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Chemical and Physical Character of the Pennsylvanian Sandstones in Central Illinois

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**CHEMICAL AND PHYSICAL
CHARACTER OF THE PENNSYLVANIAN
SANDSTONES IN CENTRAL ILLINOIS**

James C. Bradbury, Meredith E. Ostrom, and J. E. Lamar

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CHEMICAL AND PHYSICAL CHARACTER OF THE PENNSYLVANIAN SANDSTONES IN CENTRAL ILLINOIS

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ABSTRACT

Basic data for more than 90 samples of sandstones of Pennsylvanian age that crop out in the central part of Illinois are presented in this report. Chemical composition, refractoriness, size of the grains composing the sandstones, and other properties that might affect the commercial usefulness of the sandstones either now or in the future are included.

INTRODUCTION

This report deals with the sandstones of Pennsylvanian age that crop out within the coal basin of Illinois (fig. 1), except those sandstones in extreme southern Illinois that have been discussed in an earlier report (Biggs and Lamar, 1955). The sandstones dealt with here are undeveloped and constitute a mineral resource of potential future usefulness, either in their natural state or disaggregated.

A number of papers have dealt with the distribution of certain Pennsylvanian sandstones, their mineral composition, and to a lesser extent their grain shape and particle size (Andresen, 1961; Ekblaw, 1931; Glass et al., 1956; Hopkins, 1958; Potter and Glass, 1958; Rusnak, 1957; Siever, 1949, 1957; Siever and Potter, 1956). To determine the possible usefulness of the sandstones, however, additional data are needed, including chemical analyses, detailed sieve tests, and fusion point data. These data, along with information on mineral composition, percentage of heavy minerals present, and grain shape, are given in this report for samples representing considerably greater thicknesses of sandstone than were studied for earlier reports. These data will enable the mineral industry to evaluate the present uses of the sandstones and their potential value for new uses of mineral raw materials.

Acknowledgments

Several staff members of the Illinois State Geological Survey assisted in this investigation. L. D. McVicker made chemical analyses, Jack A. Simon checked Pennsylvanian stratigraphy, William F. Bradley provided x-ray data on the amount of clay in samples and the identity of clay minerals, David A. Schaefer and John D. Sims did field sampling and laboratory preparation and testing of samples, James W. Baxter and Richard D. Harvey did field sampling, and J. S. Machin supervised fusion tests.

GEOLOGIC IDENTITY OF SANDSTONES SAMPLED

Table 1 is a geologic column that shows the formations and named sandstones from which samples were taken and the number of samples obtained from each. The sampled units are separated by rocks such as shale and limestone and are not in contact with each other.

Some of the Pennsylvanian sandstones in Illinois have been given specific names, such as Pleasantview Sandstone. In some cases different names have been given to the same sandstone in different areas of the state before the sandstones were known to be equivalent. Many of the sandstones, however, have not been given specific names, but the name of the formation in which they occur is named. Such a sandstone might be referred to, for example, as "a sandstone in the Mattoon Formation." All samples described as coming from a "sandstone" of a particular formation do not necessarily come from the same sandstone stratum because most formations contain more than one sandstone.

We believe that this report includes samples from most or all of the major Pennsylvanian sandstones of Illinois, excluding those of extreme southern Illinois discussed by Biggs and Lamar (1955). More samples were tested from the formations of the McLeansboro Group, especially from the Mattoon Formation, than from other formations because this group contains many sandstone strata that are exposed at many places in south-central and southeastern Illinois.

GEOLOGIC OCCURRENCE OF SANDSTONES

The Pennsylvanian sandstones exhibit a wide variety of types of occurrence, ranging from thick, massive sandstones of considerable geographic extent, through



Fig. 1 — Sample locations, group names, and limits of areas underlain by Pennsylvanian rocks.

massive sandstones of limited geographic extent, to thin-bedded, shaly sandstones of variable extent.

The thick, massive, widespread sandstones are found in the Caseyville and Abbott Formations of the McCormick Group, the oldest of the three groups in the Pennsylvanian System of Illinois. Sandstones of the McCormick Group crop out around the edge of the Illinois Basin from southern and southwestern Illinois to Rock Island County in northwestern Illinois. Outcrops become less prominent in western and northwestern Illinois, however, as the thickness of the McCormick Group decreases from about 700 feet in southern Illinois to 100 feet or less in western Illinois (Kosanke et al., 1960). The Caseyville Formation, the lower of the two formations of the McCormick Group, generally is restricted to the southern part of the outcrop belt.

Sandstones of the McCormick Group are exposed best in extreme southern Illinois where they form prominent cliffs along the southern edge of the Illinois Basin. As most of this outcrop belt was included in the report by Biggs and Lamar (1955), the McCormick Group was not sampled extensively for our study. Only one sample from the Caseyville Formation is included. The 11 sandstone samples

TABLE 1—GEOLOGIC COLUMN AND NUMBER OF SAMPLES STUDIED

Geologic column	Number of samples taken for	
	Sieve tests	Chemical analyses
McLeansboro Group		
Mattoon Formation	31	16
Bond Formation (undifferentiated)	9	6
McWain Sandstone Member*	1	1
Mt. Carmel Sandstone Member*	1	1
Modesto Formation (undifferentiated)	10	5
Trivoli Sandstone Member	2	2
Kewanee Group		
Carbondale Formation		
Copperas Creek Sandstone Member*†	2	2
Anvil Rock Sandstone Member*†	1	1
Vermilionville Sandstone Member	9	9
Pleasantview Sandstone Member	8	8
Spoon Formation (undifferentiated)	2	2
Isabel Sandstone Member†	4	4
Palzo Sandstone Member†	2	2
Granger Sandstone Member	1	1
McCormick Group		
Abbott Formation (undifferentiated)	4	4
Bernadotte Sandstone Member‡	1	1
Murray Bluff Sandstone Member‡	1	1
Finnie Sandstone Member	2	1
Babylon Sandstone Member	3	3
Caseyville Formation	1	1

* † ‡ Each pair of symbols indicates rock units that probably are equivalent but crop out in different parts of the state.

TABLE 2 - SUMMARY OF MODAL ANALYSIS DATA

	CARBONATES*				CLAY				FELDSPAR				No. of samples examined		
	Av. amount (%)	Number of samples containing			Av. amount (%)	Number of samples containing			Av. amount (%)	Number of samples containing					
		0%	.1-10%	10.1-20%		+20%	0-5%	5.1-10%		10.1-20%	+20%	0-5%		5.1-10%	+10%
T H I N S E C T I O N S O F O U T C R O P S A M P L E S															
McLEANSBORO GROUP															
Potter & Glass, 1958	3	3	-	1	-	22	-	-	1	3	6	1	3	-	4
Siever, 1957	14	9	4	6	3	24	1	2	4	15	4	17	4	1	22
							Trivoli Sandstone Member								
Siever, 1949	-	-	-	-	-	20	-	-	-	-	-	-	-	-	?
Andresen, 1961	18	-	5†	3†	4†	9	5	6	-	1	4	8	3	1	12
							KEWANEE GROUP								
Potter & Glass, 1958	5	4	1	-	1	19	1	-	1	4	4	6	-	-	6
Siever, 1957	2	21	8	2	-	27	-	-	3	28	4	23	8	-	31
							Anvil Rock Sandstone Member								
Hopkins, 1958	3†	13†	8†	2†	2†	23	-	-	6	19	3	22	2	1	25
							Pleasantview Sandstone Member								
Rusnak, 1957	14†	-	6†	2†	2†	-	-	-	-	-	4	9	1	-	10
							Spoon Formation Sandstones in Western and Northern Illinois†								
Siever & Potter, 1956	15‡	4‡	-	-	3‡	10	2	2	3	-	2	6	1	-	7
							McCORMICK GROUP								
Potter & Glass, 1958	19	-	1	1	1	5	2	-	1	-	3	3	-	-	3
Siever, 1957	3	9	1	2	-	14	1	2	5	4	1	12	-	-	12
							Babylon Sandstone Member in Western Illinois								
Siever & Potter, 1956	0*	6	-	-	-	6	2	3	1	-	0.2	6	-	-	6

TABLE 2 — continued

Siever & Potter, 1956	0*	13*	-	-	6	7	4	2	-	0.2	13	-	-	13
THIN SECTIONS OF WELL CORES														
McLEANSBORO GROUP														
Potter & Glass, 1958	19	-	3	-	2	16	1	-	3	1	3	5	-	5
Siever, 1957	7	-	2	1	-	22	-	-	2	1	5	1	2	3
Trivoli Sandstone Member														
Andresen, 1961	16	-	3	1	3	5	5	2	-	-	4	5	2	7
KEWANEE GROUP														
Potter & Glass, 1958	25	-	-	-	3	13	1	-	1	1	2	3	-	3
Siever, 1957	12	1	6	4	2	20	-	1	4	8	3	13	-	13
Anvil Rock Sandstone Member														
Hopkins, 1958	7†	4†	24†	4†	2†	20	3	-	10	21	5	23	11	34
McCORMICK GROUP														
Potter & Glass, 1958	12	3	6	-	5	6	7	4	3	-	2	13	1	14
Siever, 1957	8	6	8	3	2	13	7	4	4	4	2	17	2	19
Caseyville Formation Sandstones in Southern Illinois														
Siever & Potter, 1956	11*	-	6*	-	3*	7	5	3	-	1	3	9	-	9

* Includes all carbonates unless otherwise specified.

† Calcite and iron carbonate.

These samples were called Tradewater by Siever and Pötter but are now recognized as Spoon Formation.

Calcite.

from the Abbott Formation were taken from 4 outcrops in western and northwestern Illinois, a drill core in Jackson County in southwestern Illinois, and 4 outcrops in southern and southwestern Illinois.

Sandstones of the Kewanee and McLeansboro Groups are not as well developed as those of the McCormick Group. Their massive sandstones typically are found as fillings of channels in the underlying beds, and in the inter-channel areas the corresponding sandstone units commonly are thin bedded and silty or shaly. The distribution of the thick, massive sandstones, as deduced from outcrop and drilling data, indicates that the channels have configurations similar to present-day stream valleys and probably represent stream-cut valleys on ancient land surfaces.

Depths and widths of the ancient valleys are variable, as would be expected, but some are of considerable size. For example, the main channel of the Anvil Rock Sandstone, one of the more prominent channel sandstones, is 2 to 3 miles wide and, not uncommonly, contains thicknesses of sandstone in excess of 100 feet (Potter and Simon, 1961). However, where such great thicknesses are encountered, it is probable that more than one sandstone unit is represented.

The Kewanee Group, represented by 29 samples mostly from western and northern Illinois, is well developed throughout the Illinois Basin. Its outcrop belt lies just inside that of the McCormick Group and forms a rude ring around the outcrop area of the younger McLeansboro Group.

The McLeansboro Group, the youngest of the three Pennsylvanian groups, forms the surface of the bedrock throughout most of the Illinois Basin and is, therefore, represented by the greatest number of samples—54. However, the McLeansboro Group is present only locally in northern Illinois, and no sandstone outcrops of this group deemed worth sampling were found farther north than Vermilion County.

RESULTS OF EARLIER STUDIES

Considerable data regarding the petrology of the Pennsylvanian sandstones have been published (references cited in Introduction), most of which are based on the examination of thin sections from hand-specimen sized samples. In this study channel samples were used, each representing a much greater thickness of sandstone than does a hand specimen. The testing methods employed also were different, except in the case of the heavy minerals tests.

Siever (1957) presented the largest body of data regarding a variety of Pennsylvanian sandstones. The major features of his data on heavy minerals are similar to those of the data in this report. Grain shape data, in so far as they can be compared, also are roughly similar. More feldspar, however, was found during the present study than in the earlier studies involving thin sections. The amount of clay mineral material found in the samples of the present study generally is less than that found in the earlier studies, although the amount of clay in some samples is about the same in both investigations.

The results of the earlier studies are summarized in tables 2 and 3. The carbonate data are not exactly comparable because some of them include only calcite, others calcite and siderite or iron carbonate, and still other data presumably cover all carbonates. However, the data suggest considerable variation in carbonate content within geologic groups and between different specimens from the same

TABLE 3—AVERAGE PERCENTAGE OF CARBONATES, CLAYS, AND FELDSPAR SHOWN BY PREVIOUS MODAL ANALYSES

No. of samples	OUTCROP SAMPLES			No. of samples	WELL CORE SAMPLES		
	Carbonates* (%)	Clay (%)	Feldspar (%)		Carbonates (%)	Clay (%)	Feldspar (%)
McLEANSBORO GROUP (Siever, 1957; Potter & Glass, 1958)							
26	12	24	4	8	15	18	4
Trivoli Sandstone Member (Andresen, 1961)							
12	18	9	4	7	16	5	4
KEWANEE GROUP (Siever, 1957; Potter & Glass, 1958)							
37	2	26	4	16	9	12	2
Pleasantview Sandstone Member† (Rusnak, 1957)							
10	14*	--	4	--	--	--	--
Anvil Rock Sandstone Member† (Hopkins, 1958)							
25	3*	23	3	34	7*	20	5
Spoon Formation Sandstones in Western and Northern Illinois†‡ (Siever and Potter, 1956)							
7	15	10	2	--	--	--	--
McCORMICK GROUP (Siever, 1957)							
15	6*	12	1	33	10*	10	2
Babylon Sandstone Member in Western Illinois†‡ (Siever and Potter, 1956)							
13	8 ^o	9	1	--	--	--	--
Caseyville Formation Sandstones in Southern Illinois† (Siever and Potter, 1956)							
13	-	6	0.2	9	11	7	3

* Includes all carbonates except where specified otherwise.

‡ Calcite and iron carbonate.

† These data not included in those for the group.

‡ These samples were called Tradewater by Siever and Potter but are now recognized as Spoon Formation.

Includes some samples that probably are in the Kewanee Group.

o Calcite.

sandstone unit. With the exception of the Pleasantview Sandstone which is high in carbonate content, the sandstones of the McLeansboro Group seem to be more calcareous than those of the Kewanee Group, whereas the McCormick Group sandstones, excepting the Caseyville sandstone which was noncalcareous in all outcrop samples examined, more often are of intermediate carbonate content.

The average carbonate content of the well core samples is higher than that of the outcrop samples (table 3). The difference in the averages is a matter of a few percent, except for the samples of Caseyville sandstone for which it is much greater. All of the Caseyville samples, most of the McLeansboro and Kewanee samples, and some of the McCormick samples contain carbonate.

Generally, the average amount of clay in the outcrop samples from the McLeansboro and Kewanee Groups was about the same, but some of the Trivoli Sandstone samples contained less than the average. The McCormick Group samples also had a lower clay average. The core samples show essentially the same relationship, although the Kewanee samples have an average intermediate to those of the other two groups.

Outcrop samples of the McCormick Group have the lowest average feldspar content (1 percent), whereas the outcrop samples from the other groups average about 4 percent feldspar. Core sample data for all the groups show variations in average feldspar content of between 2 and 5 percent.

SAMPLES

An index list of sample numbers, the counties from which the samples came, and their geologic formation appear in table 11. Descriptions of the outcrops sampled are given in the appendix and are arranged by counties. Most of the samples were taken from sandstones more than 10 feet thick, but some thinner beds were sampled either because they were the thickest available in the area or because it was thought they might have uncommon mineralogical or chemical composition.

All but three of the outcrop samples were obtained by taking blocks of stone at regular vertical intervals (generally not more than one foot) from the bottom to the top of the outcrops. If an outcrop contained more than one major kind of sandstone in strata of considerable thickness, each kind was sampled separately. The exterior weathered material was removed from each block of sandstone, but all of the samples were more or less weathered, as indicated by the oxidized condition of their iron content.

In some of the sandstones sampled, varying amounts of calcium carbonate were distributed between the sand grains as a cementing material. Other predominantly noncalcareous sandstones contained lenses or beds of sandstone so cemented. Still other sandstones were completely noncalcareous. If the sandstones contained only a few thin bands or lenses of firmly cemented calcareous sandstone, the calcareous parts usually were not included in the sample. However, some highly calcareous sandstone outcrops were sampled in their entirety.

A few of the samples proved upon testing to contain so much clay or carbonate that strict lithologic usage might require some term other than sandstone for them, but because they had the gross appearance of sandstone in the outcrops, they are so described.

CHARACTER OF UNWEATHERED SANDSTONES

Only rarely has it been possible to compare the character of the weathered sandstone in an outcrop with that of the unweathered sandstone in the same deposit several hundred feet back from the outcrop and thus determine lateral variation. It is thought, however, that the sandstones that are calcareous in outcrop are likely to be calcareous away from the outcrop. Some noncalcareous sandstone outcrops may be more or less calcareous where freshly exposed and unweathered; others, however, are believed to be noncalcareous when fresh. Test drilling is advisable to determine the character of the sandstone away from the outcrop if the carbonate content of a sandstone deposit is critical to its use.

Aside from the carbonate content, the chief differences between the fresh and weathered sandstone are believed to be as follows: (1) The fresh sandstones are more likely to be gray, or possibly nearly white, because the iron compounds present are not oxidized; (2) the actual amount of analytically determined Fe_2O_3 in the fresh samples probably is about the same as it is in the weathered samples, but the iron is present as hydrated oxides in the weathered rock, whereas in the fresh rock it is present as pyrite or marcasite (both iron sulfides) or as other iron minerals; (3) the clay mineral material in the fresh rock may be less degraded than that in the weathered stone; and (4) the unweathered sandstone may be harder than the weathered sandstone.

PREPARATION OF SANDSTONES FOR TESTING

Field samples were crushed to about one-fourth of an inch in a laboratory jaw crusher. Two fractions of about 200 grams each were split out mechanically. One was ground to 200 mesh in a ball mill and analyzed chemically. The second was used for particle size determinations and other tests. A reasonable state of disaggregation was achieved by means of a glass rolling pin and gentle rubbing in a mortar and pestle. Grain breakage or damage is believed to have been minor. Samples of firmly cemented calcareous sandstone were treated with hydrochloric acid to remove carbonates before sieving.

RESULTS OF SIEVE TESTS

Sieve tests of all samples were made with Tyler sieves. The sieving period was 10 minutes. The results of sieve tests are given in table 4. The sandstones are generally medium to fine grained but many are silty and clayey. Only 4 of the 95 samples reported in table 4 contain more than 10 percent of sand retained on a 35-mesh sieve. Twenty-one samples have more than 10 percent sand coarser than a 48-mesh sieve. The combined pan and clay fractions of 51 samples are greater than 20 percent. A major percentage of most of the samples lies in two or all three of the following sieve sizes: 65 by 100 mesh, 100 by 150 mesh, and 150 by 200 mesh.

TABLE 4—RESULTS OF SIEVE TESTS

Sample number	County	Near*	Name of sandstone	Thickness (feet)	20	28	35	48	65	100	150	200	270	Pan	Clay†
M1	Adams	Mendon	Isabel (?)	12	-	0.1	0.2	7.7	36.3	33.5	13.3	3.9	0.6	3.4	1
M2AB	Adams	Camp Point	Pleasantview	21	0.1	0.1	0.3	0.5	1.3	7.7	15.4	26.6	17.5	25.5	5
M2C*	Adams	Camp Point	Pleasantview	6	-	0.5	1.6	4.0	4.6	11.6	24.3	22.4	8.4	19.6	3
M6A†	Brown	Versailles	Babylon (?)	12	-	0.4	0.9	1.6	2.6	8.2	27.7	38.5	6.0	14.1	Tr
B68	Christian	Taylorville	Bond#	9	-	-	-	-	3.6	22.8	26.6	21.2	4.6	8.2	13
B64	Clark	Allright	Mattoon#	18	-	0.2	7.3	25.0	25.6	19.2	5.0	3.2	1.2	13.3	-
B65	Clark	Marshall	Mattoon#	25	-	-	-	7.4	28.2	31.8	10.4	4.5	2.0	5.7	10
B57	Clay	Flora	Mattoon#	15	-	1.0	9.2	30.8	28.4	11.2	3.8	2.4	1.8	5.4	6
B20*	Clinton	Beckemeyer	Modesto# (?)	10	-	-	-	-	0.3	8.7	22.8	28.9	12.8	26.5	-
M42	Coles	Charleston	Mattoon#	34	-	-	0.1	0.9	9.5	28.3	21.6	9.0	13.5	8.0	9
B61	Crawford	Flat Rock	Mattoon#	25	-	-	2.0	16.8	22.4	23.8	11.2	5.4	1.4	8.0	9
B62	Crawford	Annapolis	Mattoon#	10	-	-	-	-	4.2	48.5	19.3	7.1	4.6	16.3	-
B10	Cumberland	Woodbury	Mattoon#	15	-	-	0.2	1.0	8.6	33.2	24.4	11.4	2.8	7.4	11
B66	Edgar	Flemington	Mattoon#	20	-	-	1.2	13.2	31.6	26.6	8.0	4.4	1.6	13.4	-
B58	Edwards	Blood	Mattoon#	10	-	1.4	6.8	9.2	12.6	29.2	16.0	7.8	2.6	5.4	9
B9	Effingham	Altamont	Mattoon#	25	-	-	-	4.2	21.0	28.2	15.8	8.8	2.4	5.6	14
B56	Effingham	Hill	Mattoon#	7	-	0.8	1.6	6.6	12.4	19.8	17.2	10.2	6.8	24.6	-
B8	Fayette	La Clede	Mattoon#	18	-	-	-	0.4	0.4	2.4	9.6	19.2	13.0	33.2	22
B31A	Franklin	Plumfield	Modesto#	8	-	-	-	0.6	6.8	22.8	22.4	15.0	4.2	28.2	-
B32A†	Franklin	Thompsonville	Bond#	12	-	-	1.8	22.8	36.6	15.0	5.4	3.6	1.2	8.6	5
B32B	Franklin	Thompsonville	Bond#	7	-	-	-	8.2	25.4	22.0	14.0	9.0	2.6	8.8	10
B33	Franklin	Rend City	Bond#	12	-	-	0.6	12.6	20.0	31.2	13.4	6.6	2.2	13.4	-
M9A	Fulton	Marietta	Spoon#	12	-	0.1	0.1	0.3	1.1	4.3	18.0	45.3	12.3	16.4	2
M10	Fulton	Seville	Bernadotte	9	-	0.2	0.1	0.2	1.4	22.6	53.9	12.1	2.3	5.2	2
M40	Fulton	Sumnum	Isabel	14	-	-	0.1	0.4	4.1	31.5	27.5	11.6	3.9	8.9	12
B39	Gallatin	Kedron	Anvil Rock	20	-	0.2	4.0	9.8	24.8	21.6	10.2	6.2	2.6	5.6	15
B40A	Gallatin	Karbers Ridge	Finnie	25	-	-	0.2	4.6	28.4	30.8	11.4	5.8	2.2	12.6	4
B40B	Gallatin	Karbers Ridge	Finnie	7	-	-	-	0.8	7.8	14.2	26.0	23.4	6.8	21.0	-
B101A†	Gallatin	Kedron	Modesto#	19	-	-	-	8.9	12.5	25.7	17.4	11.0	4.1	6.3	14
B101B†	Gallatin	Kedron	Modesto#	44	-	2.0	12.6	32.4	18.2	12.4	6.3	4.2	1.9	10.0	-
B51	Greene	Roodhouse	Pleasantview	15	-	-	-	-	3.6	19.0	19.6	15.0	11.8	28.0	3
M32A	Grundy	Morris	Pleasantview	13	-	0.1	0.9	3.2	7.2	11.1	18.2	22.0	10.5	21.8	5
M32BC	Grundy	Morris	Pleasantview	15	-	0.1	0.2	3.1	6.4	10.1	17.3	21.3	9.3	22.2	8
B41	Hamilton	McLeansboro	Mattoon#	10	-	-	-	-	4.2	13.4	22.6	28.0	9.8	14.0	8
B43	Hamilton	Thackeray	Mattoon#	12	-	0.6	2.8	9.6	24.4	26.6	9.2	5.6	2.2	19.0	-

TABLE 4 — continued

Sample number	County	Near*	Name of sandstone	Thickness (feet)	20	28	35	48	65	100	150	200	270	Pan	Clay†
B6	Jackson	Bush	Modesto#	20	-	-	-	3.4	17.4	33.6	14.2	7.6	2.6	11.2	10
B100	Jackson	Oraville	Abbott#	24½	-	-	-	2.4	14.4	34.8	30.8	10.8	1.2	5.6	-
B60	Jasper	Newton	Mattoon#	8	-	-	-	-	6.4	35.8	25.0	13.6	3.0	7.2	9
B35	Jefferson	Marlow	Mattoon#	8	-	-	-	-	5.2	23.2	29.6	12.6	4.8	24.6	-
B54	Jefferson	Tamaroa	Bond#	15	-	-	-	-	6.0	53.0	15.8	6.0	4.2	10.0	5
B55	Jefferson	Divide	Mattoon#	19	-	-	-	-	7.2	34.4	22.0	10.6	3.2	8.6	14
M28A	LaSalle	Dear Park	Copperas Creek	14	-	-	-	0.1	0.6	11.9	29.9	22.6	7.3	15.6	12
M28B	LaSalle	Dear Park	Copperas Creek	12	-	0.2	2.0	4.0	4.3	9.3	14.1	14.2	9.5	23.4	19
M29	LaSalle	Marseilles	Vermilionville	12	-	0.1	0.1	0.5	5.1	32.8	28.7	11.1	3.4	10.2	8
M30A	LaSalle	Marseilles	Vermilionville	14	-	0.1	0.1	0.4	2.8	10.7	22.3	20.2	7.8	22.6	13
M30B	LaSalle	Marseilles	Vermilionville	12	-	0.1	0.1	0.5	2.0	17.3	41.0	16.5	4.3	10.2	8
M30C	LaSalle	Marseilles	Vermilionville	11	0.3	0.5	0.8	1.2	2.9	17.9	33.4	16.9	5.0	13.1	8
M31	LaSalle	Ottawa	Vermilionville	22	0.1	0.6	0.6	1.1	1.6	3.3	4.5	5.8	6.8	75.6	-
M39	LaSalle	Streator	Vermilionville	40	-	0.1	0.3	1.4	2.2	8.6	21.6	31.1	8.8	20.8	5
B63A	Lawrence	Westport	Mattoon#	10	-	-	1.4	10.8	26.8	28.8	9.2	5.2	1.8	8.0	8
B63C	Lawrence	Westport	Mattoon#	7	-	7.4	28.6	31.6	12.6	7.2	4.0	2.2	1.0	1.4	4
B52A	Marion	Salem	Mattoon#	13	-	-	-	-	2.8	9.4	28.0	27.0	5.2	27.6	-
B52B	Marion	Salem	Mattoon#	12	-	-	-	-	2.4	11.4	22.0	28.4	7.6	28.2	-
B53	Marion	Iuka	Mattoon#	12	-	0.2	1.2	5.2	17.0	34.0	15.6	7.6	2.8	16.4	-
M8AF+	McDonough	Colchester	Pleasantview	29	1.6	2.3	1.9	2.2	2.4	5.3	11.3	24.1	12.6	21.3	15
M8G	McDonough	Colchester	Pleasantview	17	-	1.2	2.3	3.3	4.0	7.9	14.4	20.2	8.2	21.5	17
M15	Mercer	Aledo	Abbott#	14	-	-	0.1	0.4	2.5	5.5	34.8	20.1	18.0	16.6	2
M17	Mercer	Hopewell	Isabel (?)	10	-	0.1	0.6	1.4	1.9	3.2	5.2	11.9	16.0	50.8	9
B3	Montgomery	Litchfield	McWain	41	-	-	1.0	5.4	14.5	27.6	16.4	10.0	3.6	6.6	15
M35	Peoria	Bartonville	Vermilionville	29	-	-	-	-	0.4	3.5	7.3	14.2	14.3	39.4	21
M36	Peoria	Bartonville	Vermilionville	16	-	-	0.1	0.2	2.0	13.5	19.1	15.5	10.0	21.6	18
M37+	Peoria	Peoria	Vermilionville	31	-	0.2	0.9	2.6	8.4	37.6	18.3	8.0	3.7	15.2	5
B24	Perry	Todds Mill	Bond#	-20	-	-	-	0.4	12.5	34.9	21.4	7.8	1.8	9.2	12
B25	Perry	Jamestown	Modesto#	14	-	-	-	-	2.7	39.6	20.2	10.4	6.7	20.4	-
B36	Pope	Oldtown	Murray Bluff	20	-	-	4.8	20.2	2.0	19.0	9.6	7.0	3.6	13.6	2
B18	Randolph	Schulline	Caseville#	20	-	0.6	3.0	15.0	29.0	35.0	9.0	2.6	0.8	3.0	2
B19	Randolph	Willisville	Babylon (?)	45	-	0.2	1.0	11.4	31.8	35.2	9.8	3.4	1.0	4.2	2
B59	Richland	Olney	Mattoon#	10	-	-	1.2	10.2	11.0	20.0	23.6	12.4	2.4	10.2	8
M12	Rock Island	Muscataine, Iowa	Isabel	30	0.1	0.1	0.1	3.7	22.7	37.4	12.8	6.1	2.6	7.4	7
M13	Rock Island	Milan	Babylon	14	1.4	3.2	7.7	24.2	22.8	22.3	6.2	3.1	1.3	5.8	2

TABLE 4 — continued

Sample number	County	Near*	Name of sandstone	Thickness (feet)	20	28	35	48	65	100	150	200	270	Pan	Clay†
B14A	St. Clair	Belleville	Modesto#	15	-	-	0.6	0.8	8.4	28.0	24.4	12.0	4.0	6.8	15
B17*	St. Clair	Freeburg	Modesto#	18	-	-	-	0.6	4.4	17.0	25.4	16.8	4.4	31.4	-
B37	Saline	Stonefort	Spoon#	15	-	-	-	-	13.6	37.0	18.6	9.2	3.8	12.8	5
B38	Saline	Harrisburg	Palzo	30	-	-	0.4	3.8	18.4	30.6	14.8	8.2	2.6	10.8	11
M38*	Sangamon	Springfield	Trivoli	40	-	0.1	0.5	1.3	2.4	8.6	21.2	25.2	10.0	22.7	8
B50	Scott	Alsey	Pleasantview	15	-	-	-	-	2.0	13.6	31.6	25.6	5.4	11.8	10
B5	Shelby	Shelbyville	Mattoon#	20	-	-	-	1.4	13.9	29.2	23.2	10.7	2.4	19.2	15
M33	Vermilion	Oakwood	Trivoli	30	-	0.5	5.6	22.0	16.5	15.3	9.2	6.3	3.7	12.9	8
M34	Vermilion	Fairmount	Bond#	13	-	0.2	1.1	2.6	3.9	11.6	27.0	19.8	5.7	18.0	10
B67	Wabash	Allendale	Mattoon#	15	-	-	5.3	22.2	15.1	22.3	9.0	6.3	2.4	17.4	-
B69	Wabash	Mt. Carmel	Mt. Carmel	35	-	-	-	6.5	28.2	34.6	8.6	4.8	1.6	6.6	9
M41	Warren	Berwick	Abbott#	12	-	0.1	0.1	0.6	0.9	4.1	16.7	44.2	12.7	18.6	2
B21	Washington	Nashville	Bond#	10	-	-	-	-	0.8	12.2	28.4	27.4	6.2	10.0	15
B22	Washington	Beaucoup	Bond#	9	-	-	-	-	2.2	16.0	27.6	18.8	6.2	29.2	-
B23C	Washington	Dubois	Modesto#	15	-	-	-	Tr.	3.0	6.0	7.8	16.4	9.6	57.2	-
B48	Wayne	Golden Gate	Mattoon#	30	-	-	-	6.6	34.4	29.4	7.8	4.6	1.6	10.6	5
B49	Wayne	Barnhill	Mattoon#	12	-	-	-	0.2	2.6	11.2	26.6	28.0	6.6	24.8	-
B44	White	Enfield	Mattoon#	10	-	-	-	-	10.0	27.0	17.2	11.6	3.8	30.4	-
B45*	White	Sumpter	Mattoon#	10	-	-	0.4	3.2	4.5	12.1	28.1	28.0	4.6	19.1	-
B46	White	Herald	Mattoon#	10	-	-	0.2	0.8	12.6	45.8	19.4	6.0	2.4	12.8	-
B47	White	Grayville	Mattoon# (?)	20	-	-	-	-	2.5	26.3	20.6	25.2	7.5	6.9	11
B27	Williamson	Carbondale	Palzo	40	-	0.4	2.6	18.6	25.8	22.6	7.9	4.8	2.2	5.1	10
B28	Williamson	Wolf Creek	Abbott#	25	-	-	-	14.2	29.6	19.4	8.6	6.0	2.0	10.2	10
B29	Williamson	Creal Springs	Granger	40	-	-	0.2	1.4	16.8	25.4	14.8	11.0	5.6	9.8	15
B30	Williamson	New Hope	Modesto#	20	-	-	-	0.8	26.3	35.7	11.7	5.6	2.8	6.1	11

* For more detailed locations see descriptions of deposits.

† Amount of clay mineral determined by X-ray. Tr equals trace.

* Carbonates removed by acid before sieving.

Name given is that of the formation in which the sandstone occurs.

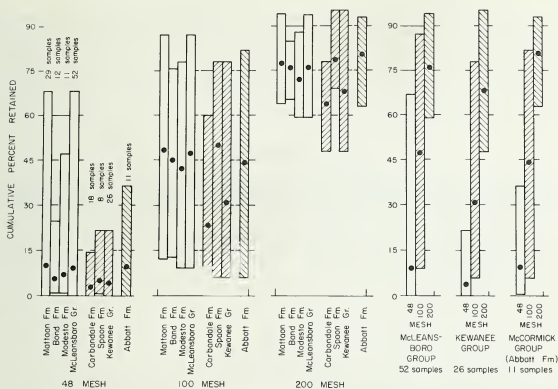


Fig. 2 — The three graphs at the left show the range (bars) and average (dots), in percent, of sand retained on the 48-, 100-, and 200-mesh sieves. Samples are arranged by geologic formations and groups. The three graphs at the right show the same data, arranged by geologic groups only. Five samples containing less than 50 percent of sand retained on the 270-mesh sieve were not included in this figure.

Figure 2 shows the range of the cumulative percentage of sand retained on the 48-, 100-, and 200-mesh sieves and of the average percentage retained on each of these sieves for the six geologic formations that were sampled, excluding the Caseyville Formation from which only one sample was taken. Five samples that contained more than 50 percent passing the 270-mesh sieve are not included in this tabulation because their strict classification as sandstones is doubtful.

Of the three formations of the McLeansboro Group, the samples of the Mattoon Formation show the greatest range in cumulative percentage of sand retained on all three sieves, and those of the Bond Formation have the smallest range. The Mattoon Formation also has the largest average percentage of sand retained on the two finest sieve sizes, whereas the Modesto Formation has the smallest average. The Bond Formation has the smallest average amount of 48-mesh sand.

The Carbondale Formation of the Kewanee Group has a smaller average percentage of sand retained on all three sieves and a smaller range in the cumulative percentage retained, except on the 200-mesh sieve, than does the Spoon Formation of the same group.

The McCormick Group is represented only by the Abbott Formation whose grain size characteristics generally resemble those of the McLeansboro Group samples more than those of the Kewanee Group.

The data in figure 2 show that there are considerable size variations within all formations, but in general the Carbondale and Spoon Formations vary least. Of the samples tested, those of the Mattoon Formation contain the coarsest sand and those of the Carbondale Formation the finest.

GRAIN SHAPE

Rough visual estimates of grain shape were made with the microscope. Ten samples—M2C, M30C, M42, B3, B9, B55, B58, B62, B63C, and B67—consisted

TABLE 5 — HEAVY MINERAL CONTENT IN SANDSTONES*†

Sample number	Heavy Minerals (%)	Anatase+Brookite	Apatite	Biotite	Chlorite	Garnet	Hematite	Ilmenite+Magnetite	Leucoxene	Limonite	Muscovite	Pyrite	Rutile	Topaz	Tourmaline	Zircon	Other
Mattoon Formation																	
B65	0.3	VR	--	--	VR	VR	--	VR	A	--	C	--	R	--	C	C	
B8	0.1	--	--	VR	--	VR	--	--	A	--	VC	VC	C	--	C	VC	Cassiterite
B5	0.3	VR	--	VR	VR	VR	--	--	A	--	R	--	VR	--	R	C	
B9	0.4	VR	VR	VR	VR	C	--	VR	A	--	C	VR	VR	--	C	VC	Kyanite (?)
M42	0.4	R	--	--	C	C	VR	C	A	--	C	--	--	--	C	VC	
B55	0.2	VR	--	VR	VR	--	--	VR	A	VR	R	--	R	--	C	C	
Bond Formation																	
M34		--	--	--	VR	VR	--	VR	A	VC	C	--	--	--	C	R	
B3	0.6	VR	VR	VR	VR	C	VR	VR	A	--	C	--	R	--	C	C	Zoisite
Modesto Formation																	
B14	0.2	R	--	VR	VR	C	VR	VR	A	VR	R	--	R	--	R	A	
M38	0.1	--	--	--	--	VR	--	--	C	A	VR	VR	--	--	VR	C	A
B30	0.2	VR	--	--	--	--	--	--	VR	A	--	C	--	VR	--	C	C
B101A	0.4	VR	--	--	VR	VR	VR	VR	A	VR	R	C	VR	--	C	A	
B101B	0.4	--	--	--	--	--	--	--	VC	--	A	C	VR	--	C	C	
Carbondale Formation																	
M28AB	0.5	R	--	--	--	--	--	--	R	A	--	R	--	VR	VR	C	C
M30AB		R	--	--	--	C	--	--	R	A	--	VR	VR	--	--	C	VC
M36		--	--	--	--	--	--	--	VR	A	VR	C	--	VR	VR	R	A
M37	0.3	C	--	--	--	--	--	--	C	A	C	VR	--	--	--	C	C
M39	0.5	--	--	--	C	--	VR	VR	A	VC	C	C	--	VR	C	--	
B50	0.3	R	--	--	VR	VR	--	VR	A	--	R	--	R	--	C	A	

dominantly of angular grains. Sample B18 was composed largely of rounded grains. Three samples, B37, M1, and M13, were mainly subrounded but contained scattered rounded grains. The rest of the samples were angular to subangular, subangular, or subangular to subrounded. About 45 percent of the 95 samples examined fell into the last category. The sandstones of the Mattoon Formation generally were more angular than those of the other formations. No other differences between formations were noted.

HEAVY MINERAL CONTENT

The major heavy minerals (minerals heavier than quartz) in the plus 270-mesh portions of 32 samples were separated in bromoform and identified with the

TABLE 5 —continued

Sample number	Heavy Minerals (%)	Anatase+Brookite	Apatite	Biotite	Chlorite	Garnet	Hematite	Ilmenite+Magnetite	Leucoxene	Limonite	Muscovite	Pyrite	Rutile	Topaz	Tourmaline	Zircon	Other
Spoon Formation																	
M1		VR	R	C	--	VR	--	C	A	VR	VR	--	VR	VR	VC	C	
M12	0.3	--	--	--	--	--	R	VC	VC	A	C	VR	--	--	--	R	
M40		C	--	--	--	VR	--	R	A	C	R	--	--	VR	C	A	
B27		R	--	--	VR	VR	VR	VR	A	VR	A	--	VR	--	C	C	
B37	0.1	VR	VR	--	--	--	--	VR	A	--	VR	VR	VR	--	C	A	Titanite
M9A		--	--	--	--	VR	--	C	A	VR	R	--	--	VR	VC	C	
B29	0.2	VR	--	--	VR	--	--	VR	A	--	C	C	VR	--	R	A	
Abbott Formation																	
M10		VR	VR	VR	--	--	--	C	A	R	R	--	VR	--	C	A	
B36	0.2	VR	--	--	--	--	--	--	A	--	VC	--	VR	--	C	C	Diopside
M41		VR	--	VR	--	VR	--	R	A	VR	C	--	R	--	C	A	
M13		--	--	--	--	--	C	C	C	A	--	VR	--	VR	VR	C	
B19	0.1	VR	--	--	--	--	VR	C	A	--	--	VR	R	--	C	VC	
Caseyville Formation																	
B18	0.2	VR	--	--	--	--	VR	--	A	VR	R	VR	R	--	C	A	

* In estimating abundance of heavy minerals the letters used have the following significance in terms of the total quantity of heavy minerals:

VR = 0 to 2%, very rare

R = 3 to 4%, rare

C = 5 to 15%, common

VC = 16 to 25%, very common

A = more than 25%, abundant

† Plus 270-mesh portion.

petrographic microscope. The results of these tests are given in table 5. The data indicate the relative abundance of the individual heavy minerals present with respect to the total heavy mineral fraction. The latter was small in all samples. The results of determinations of the actual percentage by weight of heavy minerals in 22 samples are given in the second column of table 5.

The table shows that garnet is common in some samples of the Mattoon, Bond, Modesto, and Carbondale Formations but not in any of the older formations. Ilmenite and magnetite are present in greatest quantity in the Abbott Formation and in varying amounts in other formations. Leucoxene is abundant in 29 of the 32 samples and tourmaline is common or very common in 26 of 32 samples.

Zircon is common, very common, or abundant in 29 of the 32 samples and is least abundant in the Mattoon and Bond Formations. Nine of the 32 samples contain biotite but none is present in the Carbondale samples. It is most common in the Mattoon Formation. Chlorite occurs most frequently in the Mattoon and Bond Formations; none was noted in the Abbott or Caseyville Formations.

The amount and abundance of the other heavy minerals present do not appear to be distinctive in any one or more of the geologic formations.

LIGHT MINERAL CONTENT

The principal light minerals in the sandstones are quartz and feldspar. Quartz is by far the more abundant, usually constituting 85 percent or more of the sand grains. The quantity of feldspar varies. In 32 samples on which grain counts for feldspar were made, the feldspar ranged between a trace and 20 percent by number of grains, but values between 5 and 11 percent were the most common. The amount of soda lime feldspar exceeded potash feldspar in some samples; in other samples the reverse was true, but the difference generally was small.

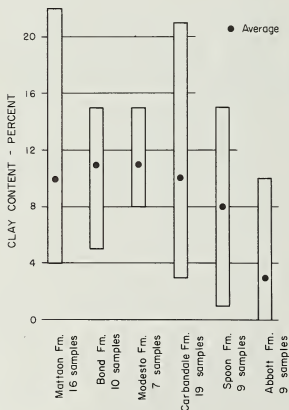


Fig. 3—Range (bars) and average (dots) clay content of samples, arranged by formations.

CLAY MINERAL CONTENT

The clay mineral content data shown in the last column of table 4, are summarized in figure 3, which shows the maximum, minimum, and average percentage of clay for the samples of the seven formations studied. The Mattoon and Carbondale Formations showed the greatest range in clay mineral content. The average for the Mattoon, Bond, Modesto, and Carbondale Formations is 10 or 11 percent, whereas

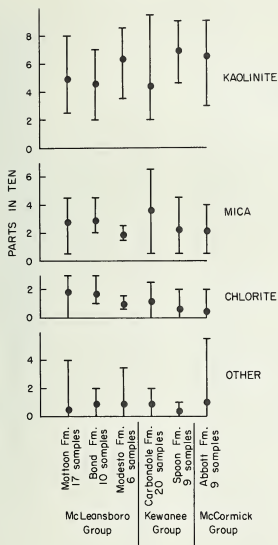


Fig. 4 — Range (bars) and average amounts (dots) of clay minerals in clay fractions of samples, arranged by formations.

it is 8 percent for the Spoon Formation and only 3 percent for the Abbott Formation.

CHARACTER OF CLAY MINERALS IN SANDSTONES

The character of the clay minerals in the clay fraction of all the samples analyzed chemically is shown in table 6 and summarized graphically in figure 4. The Mattoon, Bond, and Carbondale Formations have similar average amounts of kaolinite, ranging between 4.4 and 4.9 parts in 10, whereas the kaolinite averages of the Modesto, Spoon, and Abbott Formations range between 6.3 and 6.9.

Mica decreases as kaolinite increases. The Mattoon, Bond, and Carbondale Formations have mica averages that range between 2.8 and 3.6 parts in 10, and the averages of the other three formations range between 1.9 and 2.1.

Average chlorite content also decreases as kaolinite increases. The average chlorite content of the Mattoon, Bond, and Carbondale Formations ranges between 1.1 and 1.8 parts in 10, whereas the other three formations have a range of between 0.4 and 0.9.

In general the average amounts of other clay minerals are small and do not vary significantly with the amounts of kaolinite, mica, and chlorite.

CHEMICAL COMPOSITION

Table 7 gives the chemical composition of 71 samples of sandstone. A considerable variation exists among the different sandstones and between samples of the same formation, but the broad features shown by the analyses are indicated in table 8. Data for three samples having an ignition loss of more than 6 percent are not included in table 8 because of their high carbonate content.

The sandstones of the McCormick Group in general have a higher silica content, and a correspondingly lower content of other components, than those of

TABLE 6 — CLAY MINERALS IN THE CLAY FRACTION OF SANDSTONES*

Sample number	County	Name of sandstone	Clay minerals (parts in 10 parts)			
			Kaolinite	Mica	Chlorite	Other
M1	Adams	Isabel (?)	9.0	0.5	--	0.5
M2AB	Adams	Pleasantview	3.5	4.5	--	2.0
M2C	Adams	Pleasantview	2.0	6.5	1.0	0.5
M6A	Brown	Babylon (?)	3.5	4.0	2.0	0.5
B68	Christian	Bond†	2.0	4.0	2.0	2.0
B65	Clark	Mattoon†	5.0	2.5	2.5	?
B57	Clay	Mattoon†	5.5	2.0	2.5	?
M42	Coles	Mattoon†	8.0	1.5	0.5	--
B61	Crawford	Mattoon†	5.0	3.0	2.0	--
B10	Cumberland	Mattoon†	2.5	3.5	2.0	2.0
B58	Edwards	Mattoon†	4.0	3.5	2.5	?
B9	Effingham	Mattoon†	5.5	3.0	1.5	--
B8	Fayette	Mattoon†	3.5	3.5	3.0	--
B32A	Franklin	Bond†	7.0	2.0	1.0	--
B32B	Franklin	Bond†	3.0	2.0	3.0	2.0
M9A	Fulton	Spoon†	8.0	1.5	--	0.5
M10	Fulton	Bernadotte	8.5	1.0	--	0.5
M40	Fulton	Isabel	6.0	3.0	--	1.0
B101A	Gallatin	Modestot†	8.5	1.5	--	--
B39	Gallatin	Anvil Rock	9.5	0.5	--	--
B40A	Gallatin	Finnie	8.5	1.5	--	--
B51	Greene	Pleasantview	5.0	2.5	2.5	--
M32A	Grundy	Pleasantview	2.0	4.5	1.5	2.0
M32BC	Grundy	Pleasantview	4.0	4.0	0.5	1.5
B41	Hamilton	Mattoon (?)†	3.0	4.0	3.0	--
B26	Jackson	Modestot†	7.0	2.0	1.0	--
B60	Jasper	Mattoon†	3.0	2.5	2.5	2.0
B54	Jefferson	Bond†	6.5	2.0	1.5	--
B55	Jefferson	Mattoon†	5.5	2.0	2.5	?
M28A	LaSalle	Copperas Creek	4.5	4.0	0.5	1.0
M28B	LaSalle	Copperas Creek	2.5	4.5	2.0	1.0
M29	LaSalle	Vermilionville	5.0	3.5	1.0	0.5
M30A	LaSalle	Vermilionville	3.0	4.5	1.0	1.5
M30B	LaSalle	Vermilionville	5.0	3.5	0.5	1.0
M30C	LaSalle	Vermilionville	4.5	3.5	1.5	0.5
M31	LaSalle	Vermilionville	2.5	5.0	2.0	0.5
M39	LaSalle	Vermilionville	5.5	2.5	1.5	0.5
B63A	Lawrence	Mattoon†	5.5	3.5	1.0	--
B63C	Lawrence	Mattoon†	5.5	0.5	--	4.0
B52AB	Marion	Mattoon†	5.5	4.5	--	--

TABLE 6 — continued

Sample number	County	Name of sandstone	Clay minerals (parts in 10 parts)			
			Kaolinite	Mica	Chlorite	Other
M8AF	McDonough	Pleasantview	2.5	5.5	1.5	0.5
M8G	McDonough	Pleasantview	3.0	5.0	1.0	1.0
M15	Mercer	Abbott†	7.0	1.5	--	1.5
M17	Mercer	Isabel (?)	5.0	4.5	--	0.5
B3	Montgomery	McWain	4.0	2.0	2.0	2.0
M35	Peoria	Vermilionville	3.5	4.0	1.5	1.0
M36	Peoria	Vermilionville	5.5	2.5	0.5	1.5
M37	Peoria	Vermilionville	7.5	2.0	0.5	--
B24	Perry	Bond†	5.5	3.5	1.0	--
B36	Pope	Murray Bluff	5.0	5.0	--	--
B18	Randolph	Caseyville†	3.5	--	1.5	5.0
B19	Randolph	Babylon(?)	6.0	2.5	1.5	--
B59	Richland	Mattoon†	5.0	2.5	2.5	--
M12	Rock Island	Isabel	8.0	1.5	--	0.5
M13	Rock Island	Babylon	9.0	0.5	--	0.5
B14A	St. Clair	Modesto†	3.5	1.5	1.5	3.5
B37	Saline	Spoon†	7.0	1.5	1.5	--
B38	Saline	Palzo	6.0	2.0	2.0	--
M38	Sangamon	Trivoli	6.0	2.5	1.0	0.5
B50	Scott	Pleasantview	4.0	2.0	2.0	2.0
B5	Shelby	McWain	6.0	3.0	1.0	--
M33	Vermilion	Trivoli	5.5	2.5	0.5	1.5
M34	Vermilion	Bond†	3.5	4.5	1.5	0.5
B69	Wabash	Mt. Carmel	4.0	2.0	2.0	2.0
M41	Warren	Abbott†	8.0	1.5	--	0.5
B21	Washington	Bond†	4.5	4.0	1.5	--
B48	Wayne	Mattoon†	8.0	2.0	--	--
B47	White	Mattoon†	4.0	3.0	3.0	--
B27	Williamson	Palzo	8.5	1.5	--	--
B28	Williamson	Abbott†	3.0	1.5	--	5.5
B29	Williamson	Granger	4.5	3.5	2.0	--
B30	Williamson	Modesto†	7.0	1.5	1.5	--

* Determined on -2 micron material for M samples and on -270 mesh material for B samples.

† Name given is that of the formation in which the sandstone occurs.

TABLE 7 — CHEMICAL ANALYSES OF SANDSTONES
(Analyses by L. D. McVicker in the laboratories of the Illinois State Geological Survey)

Sample number	County	Near*	Name of Sandstone	Thickness (ft.)	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	CaO	Na ₂ O	K ₂ O	Loss on ignition	Total	Remarks
M1	Adams	Mendon	Isabel (?)	12	96.04	.11	3.07	.18	.07	.08	.05	.12	.73	100.45	Total outcrop
M2AB	Adams	Camp Point	Pleasantview	21	74.59	.84	13.04	4.69	1.06	.33	1.69	2.05	3.15	101.44	Upper part of outcrop
M2C	Adams	Camp Point	Pleasantview	6	48.50	.55	8.48	3.09	.91	19.45	1.28	1.35	17.09	100.70	CO ₂ - 15.57%; below MS 2AB
M6A	Brown	Versailles	Babylon (?)	12	47.77	.21	3.66	1.99	2.65	21.93	.90	.40	20.65	100.16	CO ₂ - 20.09%; 6½ to 18½ feet above base of outcrop
B68	Christian	Taylorville	Bond†	9	81.95	.68	9.45	2.44	.51	.31	1.58	1.58	1.80	100.30	
B65	Clark	Marshall	Mattoon†	25	84.35	.42	8.64	1.82	.45	.23	1.45	1.44	1.50	100.30	
B57	Clay	Flora	Mattoon†	15	87.15	.28	6.57	2.29	.11	.11	.73	1.60	1.36	100.20	
M42	Coles	Charleston	Mattoon†	34	83.47	.83	9.09	2.21	.47	.20	1.35	1.05	1.65	100.32	Total outcrop
B61	Crawford	Flat Rock	Mattoon†	25	85.11	.46	7.60	2.68	.36	.14	.72	1.38	1.78	100.23	
B10	Cumberland	Woodbury	Mattoon†	15	78.16	.74	11.08	3.10	.61	.57	1.77	1.78	2.42	100.23	
B58	Edwards	Blood	Mattoon†	10	86.41	.54	7.01	2.10	.18	.22	1.02	1.43	1.34	100.25	
B9	Effingham	Altamont	Mattoon†	25	81.68	.56	8.98	3.21	.42	.23	1.33	1.73	1.97	100.11	
B8	Fayette	LaGrade	Mattoon†	18	72.28	.79	10.58	3.57	.95	3.98	1.28	1.51	5.07	100.01	
B32A	Franklin	Thompsonville	Bond†	12	87.04	.36	6.98	1.58	.24	.34	.98	1.53	1.36	100.41	
M9A	Fulton	Marietta	Spoon†	12	91.97	.55	4.93	.75	.22	.03	.10	.56	1.32	100.43	7 to 19 feet above base of outcrop
M10	Fulton	Seville	Bernadotte	9	93.85	.38	3.83	.40	.15	.02	.10	.40	.96	100.09	Total outcrop
M40	Fulton	Sumnum	Isabel	14	84.45	.66	9.21	1.55	.41	.15	1.41	1.50	1.59	100.93	Total outcrop
B101A	Gallatin	Kedron	Modesto†	19	78.96	.58	9.51	2.55	.72	1.24	.15	1.57	4.63	99.91	Sandstone from diamond drill core.
B101B	Gallatin	Kedron	Modesto†	44	83.38	.23	5.84	2.06	.92	2.27	.08	.64	4.72	100.14	Sandstone from diamond drill core.
B39	Gallatin	Kedron	Anvil Rock	20	86.92	.43	7.27	2.50	.08	.05	.10	.70	2.23	100.28	
B40A	Gallatin	Karbers Ridge	Finnie	25	91.16	.37	4.39	2.32	.04	.11	.10	.53	1.22	100.24	
B51	Greene	Roodhouse	Pleasantview	15	80.12	.73	9.67	2.53	.60	.21	1.29	1.37	3.65	100.17	
M32A	Grundy	Morris	Pleasantview	13	62.01	.83	8.07	3.15	.72	11.97	1.03	1.40	11.01	100.19	CO ₂ - 9.54; upper 13 feet exposed.
M32BC	Grundy	Morris	Pleasantview	15	77.60	.77	9.78	4.40	.63	.73	1.30	1.95	3.18	100.34	Lower 15 feet exposed.
B41	Hamilton	McLeansboro	Mattoon (?)	10	84.55	.76	8.44	1.95	.40	.21	.95	1.28	1.85	100.39	
B26	Jackson	Bush	Modesto†	20	85.07	.54	8.00	2.15	.36	.16	.89	1.57	1.63	100.37	
B100	Jackson	Oraville	Abbott†	24½	96.35	.14	2.07	.78	.03	.08	.05	.10	.53	100.13	Sandstone from diamond drill core.
B60	Jasper	Newton	Mattoon†	8	84.92	.72	8.07	2.04	.40	.18	1.23	1.16	1.58	100.30	
B54	Jefferson	Tamaroa	Bond†	15	87.88	.50	6.97	1.14	.05	.12	1.07	1.13	1.25	100.11	

B55	Jefferson	Divide	Mattoont	19	84.70	.53	8.73	1.43	.33	.16	1.40	1.63	1.37	100.28	12 to 26 feet above base of outcrop.
M28A	LaSalle	Deer Park	Cooperas Creek	14	81.01	.79	10.12	2.39	.56	.20	1.28	1.60	2.45	100.40	0 to 12 feet above base of outcrop.
M28B	LaSalle	Deer Park	Copperas Creek	12	68.02	.89	12.96	5.77	1.16	2.84	1.06	2.18	5.64	100.52	base of outcrop. Upper part of outcrop.
M29	LaSalle	Marseilles	Vermilionville	12	79.89	.70	9.83	3.22	.57	.18	1.18	2.18	2.56	100.31	26 to 40 feet above base of outcrop.
M30A	LaSalle	Marseilles	Vermilionville	14	73.29	.87	12.76	5.18	.87	.15	1.17	2.64	3.55	100.48	14 to 26 feet above base of outcrop.
M30B	LaSalle	Marseilles	Vermilionville	12	80.28	.71	10.21	2.55	.56	.16	1.17	2.26	2.43	100.33	base of outcrop.
M30C	LaSalle	Marseilles	Vermilionville	11	77.53	.76	9.83	3.34	.56	1.72	1.13	2.14	3.62	100.63	3 to 14 feet above base of outcrop.
M31	LaSalle	Ottawa	Vermilionville	22	63.40	1.05	17.45	6.24	2.13	.52	1.38	2.74	5.44	100.35	Upper part of outcrop.
M39	LaSalle	Streator	Vermilionville	40	79.09	.87	10.43	2.23	.57	.97	1.25	1.47	3.54	100.42	Total outcrop.
B63AC	Lawrence	Westport	Mattoont	17	87.20	.26	5.99	2.82	.17	.28	.83	1.45	1.28	100.39	CO ₂ - 1.37%; 3 to 31½ feet below top of outcrop.
B52AB	Marion	Salem	Mattoont	25	82.69	.84	9.08	2.27	.51	.22	1.28	1.38	1.96	100.23	31½ to 43½ feet below top of outcrop.
M8AF	McDonough	Colchester	Pleasantview	29	71.85	.83	12.27	4.48	.91	1.80	1.59	1.91	4.98	100.62	10 to 24 feet above base of outcrop.
M8G	McDonough	Colchester	Pleasantview	17	73.94	.88	12.97	4.84	.88	.14	1.54	1.99	4.04	101.22	Total outcrop.
M15	Mercer	Aledo	Abbott†	14	93.20	.45	4.30	.81	.08	.15	.10	.47	1.04	100.60	CO ₂ - 1.64%; lower part of outcrop.
M17	Mercer	Hopewell	Isabel (?)	10	73.33	.86	11.61	5.01	.76	1.58	1.57	1.81	3.96	100.49	Upper part of outcrop.
B3	Montgomery	Litchfield	McWain	41	81.95	.62	9.40	2.87	.37	.29	1.40	1.45	1.95	100.30	Total outcrop.
M35	Peoria	Bartonville	Vermilionville	22½	76.07	.87	11.73	3.83	1.03	.38	1.47	1.70	3.38	100.46	Lower 16 feet of 17 feet exposed.
M36	Peoria	Bartonville	Vermilionville	16	78.25	.88	12.21	2.10	.64	.22	1.48	1.71	2.99	100.48	CO ₂ - 1.64%; lower part of outcrop.
M37	Peoria	Peoria	Vermilionville	28	81.52	.49	8.23	2.02	.47	1.95	1.33	.95	3.39	100.35	Upper part of outcrop.
B24	Perry	Todds Mill	Bond†	20	88.27	.35	6.48	1.36	.11	.13	.77	1.45	1.25	100.17	Upper part of outcrop.
B36	Pope	Oldtown	Murray Bluff	20	89.40	.30	5.54	1.54	.13	.12	.80	1.16	1.09	100.08	
B18	Randolph	Schuline	Caseyville†	20	96.17	.11	2.01	.76	.09	.12	.05	.05	.77	100.13	
B19	Randolph	Willisville	Babylon (?)	45	96.65	.17	1.96	.58	.05	.08	.05	.27	.59	100.40	
B59	Richland	Olney	Mattoont	10	83.37	.52	9.23	1.75	.37	.35	1.83	1.40	1.48	100.30	
M12	Rock Island	Muscatine, Iowa	Isabel (?)	30	84.57	.40	7.99	2.43	.39	.14	1.16	2.14	1.63	100.85	
M13	Rock Island	Milan	Babylon	14	83.91	.21	4.72	7.89	.39	.40	.05	.20	3.10	100.87	

TABLE 7—Continued
(Analyses by L. D. McVicker in the laboratories of the Illinois State Geological Survey)

Sample number	County	Near*	Name of Sandstone	Thickness (ft)	SiO ₂	TiO ₂	Al ₂ O ₃	Fe ₂ O ₃	MgO	CaO	Na ₂ O	K ₂ O	Loss on ignition	Total	Remarks
B14A	St. Clair	Belleville	Modestot†	15	79.16	.83	10.71	3.36	.78	.32	1.52	1.10	2.50	100.28	
B37	Saline	Stonesfort	Spoon†	15	83.58	.48	9.12	1.78	.30	.27	1.18	1.44	2.03	100.18	
B38	Saline	Harrisburg	Palzo	30	81.51	.59	10.31	1.95	.42	.15	.98	1.87	2.60	100.38	
M38	Sangamon	Springfield	Trivoli	40	77.11	.92	10.69	2.77	.83	1.40	1.77	1.65	3.25	100.39	Total outcrop. CO ₂ - 1.09%.
B50	Scott	Alsey	Pleasantview	15	82.34	.75	9.28	2.47	.35	.18	.97	1.22	1.89	99.45	
M33	Vermillion	Oakwood	Trivoli	30	85.71	.28	7.11	3.62	.36	.15	.90	.98	1.75	100.86	Total outcrop.
M34	Vermillion	Fairmount	Bond†	13	76.46	.92	10.24	4.09	.90	1.27	1.68	1.49	3.47	100.52	Total outcrop.
B69	Wabash	Mt. Carmel	Mt. Carmel	35	86.73	.35	7.41	1.28	.36	.20	1.32	1.50	1.32	100.47	
M41	Warren	Berwick	Abbott†	12	91.95	.49	5.12	.50	.10	.06	.15	.67	1.19	100.23	Total outcrop.
B21	Washington	Nashville	Bond†	10	82.09	.83	9.48	2.13	.33	.23	1.47	1.37	1.99	99.92	
B48	Wayne	Golden Gate	Mattoon(?)†	30	86.16	.64	7.49	2.03	.25	.14	.83	.97	1.63	100.14	
B47	White	Grayville	Mattoon(?)†	20	83.99	.80	8.80	1.65	.38	.21	1.28	1.01	1.40	99.52	
B27	Williamson	Carbondale	Palzo	40	85.57	.39	7.25	2.68	.26	.15	.48	1.72	1.88	100.38	
B28	Williamson	Wolf Creek	Abbott†	25	85.21	.30	6.50	4.18	.13	.09	.08	1.78	1.88	100.15	
B29	Williamson	Creal Springs	Granger	40	78.98	.68	10.12	3.44	.76	.72	1.28	1.85	2.56	100.39	
B30	Williamson	New Hope	Modestot	20	87.18	.39	6.78	1.95	.16	.14	.97	1.08	1.49	100.14	

* For more detailed locations see descriptions of deposits in appendix.

† Formation in which the sandstone occurs.

TABLE 8 — SUMMARY OF CHEMICAL ANALYSES OF SANDSTONES BY FORMATION

	Dominant percentages or percentage range*		
	McCormick Group	Kewanee Group	McLeansboro Group
SiO ₂ †	95, 90	80 (75, 85)	85, 80
Al ₂ O ₃ ‡	(2, 4)	10 (12, 13)	9, 7
Fe ₂ O ₃ ‡	1, 2	2, 3	2, 3
MgO‡	< $\frac{1}{2}$	1, < $\frac{1}{2}$	< $\frac{1}{2}$, 1
CaO‡	< $\frac{1}{2}$	< $\frac{1}{2}$, 1	< $\frac{1}{2}$, 1
TiO ₂	.25 to .50	.51 to .75	.26 to 1.00
Na ₂ O	0 to .25	1.01 to 1.50	.76 to 1.50
K ₂ O	0 to .50	1.26 to 2.25	1.01 to 1.75
Ignition loss‡	1	2, 3	2, 1
Number of samples	11	26 (3 highly calcareous samples omitted)	31

* The figures on dominant percentages (first five and last lines) are arranged in order of decreasing importance from left to right. Parentheses around two numbers indicate the percentages occur with equal frequency.

† Percentages rounded to nearest 5%.

‡ Percentages rounded to nearest 1%.

the other two groups. The samples of the Kewanee Group generally are somewhat lower in silica content and higher in content of most other components than those of the other two groups. The McLeansboro Group samples are mostly of an intermediate compositional character.

FUSION TESTS

Because many of the sandstone samples were so friable that it was not feasible to cut specimens from them for fusion tests, portions of all the samples were disaggregated to sand. The sand was mixed with a binder (an aqueous solution of gum tragacanth) and molded into 2¼-inch pyramidal "cones." The cones were dried, then heated to various temperatures in an electric furnace at a rate of about 150°C per hour. The cones were held at peak temperature for about 40 minutes.

Cones of all samples were initially heated to 1300°C (2372°F). Fresh cones of those sandstones that had fused or were badly bent over and thus were near fusion were heated to 1100°C (2012°F). Fresh cones of those sandstones that did not fuse or approach fusion at 1300°C were heated to 1500°C (2732°F). The results of these tests follow.

Samples Not Fused at 1500°C (2732°F)

Nine samples (table 9) had not fused at 1500°C. The cones of all these samples were brown or a dirty cream color except M13, which was mottled black and red. The samples, except M13, are characterized by a content of more than

TABLE 9 — RESULTS OF FUSION TESTS

Samples that had not fused at 1500°C (2732°F)				
	B18		M10	
	B19		M13	
	B100		M15	
	M1		M41	
	M9A			
Samples that fused between 1300 and 1500°C (2372° - 2732°F)				
B17	B36	B50	B63C	M12
B24	B38	B52B	B64	M28A
B25	B39	B53	B65	M29
B26	B40A	B54	B67	M30A
B27	B40B	B57	B68	M30B
B30	B41	B58	B69	M33
B31A	B45	B59	B101A	M35
B32A	B46	B60	B101B	M40
B32B	B47	B61	M8AF	M42
B33	B48	B62	M8G	
Samples that fused between 1100 and 1300°C (2012 - 2372°F)				
B3	B23C	B51	M6A	M36
B7	B28	B52A	M17	M37
B8	B29	B55	M28B	M38
B9	B35	B56	M30C	M39
B10	B37	B63A	M31	
B14A	B43	B66	M32A	
B21	B44	M2AB	M32BC	
B22	B49	M2C	M34	
No samples fused at 1100°C (2012°F)				

90 percent silica, 5 percent or less alumina, less than 1 percent iron oxide, less than one-half percent calcium oxide, and less than 1 percent alkalies (sodium and potassium oxides). Sample M13 is high in iron oxide and contains only 84 percent silica.

To determine whether pieces of actual sandstone would give results similar to those for the cones when heated, specimens of the sandstone roughly 2 inches long and one-half to three-fourths inches in diameter were fired at 1500°C. None of the samples fused. Samples M1 and B18 were friable after the firing and sample M13 was somewhat friable. The other six samples were hard.

Sample M1 was light tan, sample M9A was gray with brown spots, sample M10 was grayish white with small brown spots, sample M13 was cream with brown spots, sample M15 was grayish white with brown streaks, sample M41 was white with scattered tiny brown spots, sample B18 was light cream with brown spots, sample B19 was light brown and brown, and sample B100 was brown.

Samples Fused Between 1300°C (2372°F) and 1500°C (2732°F)

Forty-nine samples (table 9) fused between 1300° and 1500°C. The samples in this group generally contain less silica, more alumina, more iron oxide, somewhat

more calcium oxide, and much more of the alkalies than those above.

Samples Fused Between 1100°C (2012°F) and 1300°C (2372°F)

Thirty-six samples (table 9) fused between 1100°C and 1300°C. The samples in this group were mostly lower in silica and much higher in calcium oxide than those in the preceding group.

Refractoriness, Clay Content and Character, and Loss on Ignition

Figure 5 shows that the samples whose fusion points were above 1500°C contained only a small amount of clay mineral and that the major clay mineral present was kaolinite. The average and range in amount of clay in the samples that fused between 1300° and 1500°C and those that fused between 1100° and 1300°C were about the same, but the samples that fused at the higher temperatures on the average contained a greater amount of the more refractory clay mineral kaolinite and somewhat less of the other three less refractory clay minerals.

The figures for loss on ignition show an increase in range and average value from the most refractory to the least refractory groups of samples. Whereas a small loss on ignition value may not reflect the presence of carbonates, the larger values do and therefore probably indicate a high carbonate content in some of the samples that fuse between 1100° and 1300°C. The carbonate is thought to occur mainly as calcium carbonate, which is a flux.

Refractoriness and Geologic Age

Table 10 shows the relation between the fusion temperatures of the sandstone samples and their geologic age according to groups. The samples of the

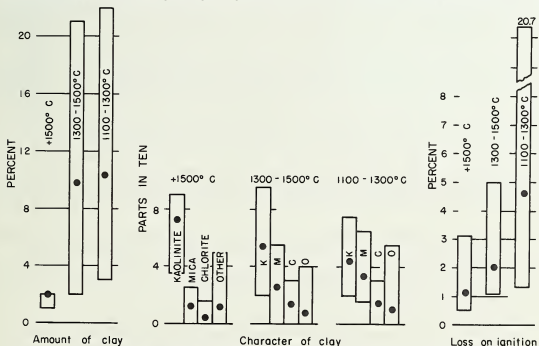


Fig. 5 — Relation between fusion temperature and amount of clay, character of clay, and loss on ignition of sandstones. Range in values (bars) and averages (dots) are shown.

TABLE 10 — RESULTS OF FUSION TESTS BY GEOLOGIC GROUP

Group	No. of samples	Percentage
Fused between 1100 and 1300°C		
McLeansboro	20	56
Kewanee	14	39
McCormick	2	5
Fused between 1300 and 1500°C		
McLeansboro	32	65
Kewanee	14	29
McCormick	3	6
Not fused at 1500°C		
McLeansboro	0	0
Kewanee	2	22
McCormick	7	78

McLeansboro Group were the least refractory, those of the McCormick Group the most refractory, and those of the Kewanee Group intermediate.

USES FOR THE SANDSTONES

Some of the Pennsylvanian sandstones of northern Illinois possibly could be used in their natural state as building stone or firestone, as an additive in the making of mineral wool, or as an abrasive. As no exact specifications are known for some of these uses, it is impossible to give specific recommendations. Sandstone to be used as building stone should have a pleasing color, occur in well layered deposits, be adequately cemented, and have good resistance to weather.

Firestone is a refractory sandstone used for the upper side-walls of soaking pits for steel ingots (American Society for Testing Materials, 1957) and for lining acid Bessemer converters and cupolas (Camp and Francis, 1957). Among other important properties that firestone must possess are good coherence and refractoriness. A high silica content generally is a rough measure of the latter property. Camp and Francis (1957) stated that firestones contain 90 to 93 percent silica, about 4 percent alumina, and 2 to 4 percent ferric oxide, lime, and magnesia.

Samples M1, M9A, M10, M15, M41, B19, and B100 approach or virtually equal this composition and they withstood a temperature of 2732°F in the fusion tests.

In making mineral wool from slag it is sometimes desirable to add "silica rock" in relatively small amounts. The desired composition of the rock varies, and, as the table of chemical analyses (table 7) indicates, sandstones of widely diverse composition are available for this purpose, including sandstones of relatively high silica, alumina, or lime content.

Various kinds of abrasive stones, such as grindstones and whetstones, are made in limited numbers from sandstone. A combination of proper grain size, degree of cementation, and grain shape usually is required, and these characteristics vary for different abrasive stones. No exact specifications have been found for abrasive stones, but it is unlikely that the high clay and high carbonate samples

in this investigation would be promising for such use.

If the sandstones were mechanically broken down and the sand suitably processed, glass sand, molding sand, asphalt sand, or sand for other purposes might be produced from some of these sandstones. The sandstones high in silica normally would offer most promise for such uses.

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TABLE 11 — SAMPLE NUMBERS WITH COUNTY AND FORMATION IDENTIFICATION

Sample number	County	Formation	Sample number	County	Formation
Samples with "B" Prefix					
3	Montgomery	Bond	43	Hamilton	Mattoon
5	Shelby	Bond	44	White	Mattoon
7	Shelby	Mattoon	45	White	Mattoon
8	Fayette	Mattoon	46	White	Mattoon
9	Effingham	Mattoon	47	White	Mattoon
10	Cumberland	Mattoon	48	Wayne	Mattoon
14A	St. Clair	Modesto	49	Wayne	Mattoon
17	St. Clair	Modesto	50	Scott	Carbondale
18	Randolph	Caseyville	51	Greene	Carbondale
19	Randolph	Abbott	52A	Marion	Mattoon
20	Clinton	Modesto	52B	Marion	Mattoon
21	Washington	Bond	53	Marion	Mattoon
22	Washington	Bond	54	Jefferson	Bond
23C	Washington	Modesto	55	Jefferson	Mattoon
24	Perry	Bond	56	Effingham	Mattoon
25	Perry	Modesto	57	Clay	Mattoon
26	Jackson	Modesto	58	Edwards	Mattoon
27	Williamson	Spoon	59	Richland	Mattoon
28	Williamson	Abbott	60	Jasper	Mattoon
29	Williamson	Spoon	61	Crawford	Mattoon
30	Williamson	Modesto	62	Crawford	Mattoon
31A	Franklin	Modesto	63A	Lawrence	Mattoon
32A	Franklin	Bond	63C	Lawrence	Mattoon
32B	Franklin	Bond	64	Clark	Mattoon
33	Franklin	Bond	65	Clark	Mattoon
35	Jefferson	Mattoon	66	Edgar	Mattoon
36	Pope	Abbott	67	Wabash	Mattoon
37	Saline	Spoon	68	Christian	Bond
38	Saline	Spoon	69	Wabash	Bond
39	Gallatin	Carbondale	100	Jackson	Abbott
40A	Gallatin	Abbott	101A	Gallatin	Modesto
40B	Gallatin	Abbott	101B	Gallatin	Modesto
41	Hamilton	Mattoon			
Samples with "M" Prefix					
1	Adams	Spoon	30A	LaSalle	Carbondale
2AB	Adams	Carbondale	30B	LaSalle	Carbondale
2C	Adams	Carbondale	30C	LaSalle	Carbondale
6A	Brown	Abbott	31	LaSalle	Carbondale
8AF	McDonough	Carbondale	32A	Grundy	Carbondale
8G	McDonough	Carbondale	32BC	Grundy	Carbondale
9A	Fulton	Spoon	33	Vermilion	Modesto
10	Fulton	Abbott	34	Vermilion	Bond
12	Rock Island	Spoon	35	Peoria	Carbondale
13	Rock Island	Abbott	36	Peoria	Carbondale
15	Mercer	Abbott	37	Peoria	Carbondale
17	Mercer	Spoon	38	Sangamon	Modesto
28A	LaSalle	Carbondale	39	LaSalle	Carbondale
28B	LaSalle	Carbondale	40	Fulton	Spoon
29	LaSalle	Carbondale	41	Warren	Abbott
			42	Coles	Mattoon

APPENDIX DESCRIPTION OF DEPOSITS SAMPLED

ADAMS COUNTY		Ft. In.
Sample M1 - SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 36, T. 2 N., R. 8 W., 2 miles north of Mendon. Bank on west side of creek.		buff, fine to medium grained; base covered (sample B68) 9
Spoon Formation	Ft. In.	
Isabel (?) Sandstone Member		
Upper part of outcrop tan, lower part gray; beds range from thin to about 2 feet thick, bedding irregular; outcrop weathered; overlies limestone of Mississippian age (sample M1)	12	
Samples M2AB, M2C - NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 9, T. 1 N., R. 6 W., 3 miles northwest of Camp Point. Roadcut.		
Surficial material	10±	
Shale, sandy, thin bedded	5	
Carbondale Formation		
Pleasantview Sandstone Member		
Sandstone, fine grained, micaceous, thin bedded, shaly; lower 8 inches carbonaceous; slightly calcareous (sample M2AB)	21	
Sandstone, gray, micaceous, very calcareous, fine grained, hard; base covered (sample M2C)	6	
BROWN COUNTY		
Sample M6A - NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, T. 2 S., R. 2 W., 3 miles east of Versailles. Stream cut.		
Clay shale, gray	4	
Limestone, brown, sandy	10	
Abbott Formation		
Babylon (?) Sandstone Member		
Sandstone, reddish brown and gray, massive, dense, very calcareous; many bands of limestone up to $\frac{1}{2}$ inch thick (sample M6A)	12	
Sandstone, gray, fine grained, yellow-brown	1	
Siltstone, brown	1½	
Siltstone, clayey; base covered	4	
CHRISTIAN COUNTY		
Sample B68 - SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 19, T. 13 N., R. 2 W., $\frac{1}{2}$ mile southwest of Calloway. Northwest bank of tributary to South Fork Sangamon River.		
Glacial till	4	
Bond Formation		
Sandstone, massive, medium bedded,		
CLARK COUNTY		
Sample B64 - SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 4, T. 9 N., R. 12 W., 2½ miles south of Allright. Ledges in banks of ravine, south side of Joes Fork.		
Soil	1	
Mattoon Formation		
Sandstone, massive, thin cross-bedded zones, light brown, locally reddish brown from iron oxide; weathered, soft and friable; base covered (sample B64)	18	
Sample B65 - SE $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 34, T. 12 N., R. 12 W., 3½ miles north of Marshall. High bluffs southwest side of West Fork just west of bridge.		
Covered; probably largely sandstone as below; glacial drift may be 10 to 20 feet thick	40	
Mattoon Formation		
Sandstone, massive, buff to brown, medium grained; weathered, very soft and friable (sample B65)	25	
Conglomerate, shale pebbles	1	
Shale, black, fissile; at water level		
CLAY COUNTY		
Sample B57 - NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4, T. 2 N., R. 6 E., 3 miles southwest of Flora. Overhanging bluffs along south bank Raccoon Creek for about $\frac{1}{4}$ mile west of bridge.		
Glacial till	3	
Mattoon Formation		
Sandstone, massive, light brown to brown, medium to coarse grained; base covered (sample B57)	15+	
CLINTON COUNTY		
Sample B20 - SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ and NW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 35, T. 2 N., R. 3 W., 3 miles southwest of Carlyle. Ten foot thickness of sandstone exposed in two outcrops on Stone Quarry Creek. Lower 7 feet exposed in east bank of tributary from south, 100 feet up tributary		

from junction with Stone Quarry Creek; upper 3 feet is in ledges along and in bed of Stone Quarry Creek, exposed more or less continuously for 1/8 mile downstream from bridge, 1/2 mile west of lower outcrop.

Soil 1-2

Modesto Formation

Sandstone, thin bedded, gray fine grained, micaceous, somewhat calcareous 2

Sandstone, gray, calcareous, fossiliferous 1

Sandstone, as in uppermost unit, shaly in bottom 1 foot; base covered 7

(Sample B20 from all 3 sandstone units)

COLES COUNTY

Sample M42 - NW 1/4 NE 1/4 SE 1/4 sec. 18, T. 12 N., R. 10 E., in bluff of Embarrass River east of Charleston.

Soil 1+

Mattoon Formation

Sandstone, weathered and soft 4

Sandstone, tan and light gray, fine to medium grained, friable, massive, with scattered limonite nodules and rarely thin shaly lenses; base covered

(Sample M42 from the 2 sandstone units 30

CRAWFORD COUNTY

Sample B61 - SE 1/4 NW 1/4 sec. 36, T. 6 N., R. 12 W., 1 1/2 miles northwest of Flat Rock. Outcrops in roadcut, in stream bank 1/2 mile northwest of bridge at roadcut, and in streambed ledges between roadcut and stream bank outcrops.

Soil 1-2

Mattoon Formation

Sandstone, massive, light brown, medium grained; weathered, very soft and friable; exposed in roadcut 15

Sandstone, as above, but not so deeply weathered and soft; exposed in stream bank 7

Sandstone, as above; base covered

(Sample B61 from the 3 sandstone units 4

Sample B62 - SW 1/4 NE 1/4 SW 1/4 sec. 5, T. 8 N., R. 12 W., 2 1/2 miles northeast of Annapolis. Overhanging bluff southeast side of stream 50 feet

west of road.

Soil 1-2

Mattoon Formation

Sandstone, massive, light brown, fine grained; 2 thin bedded zones with carbonaceous partings, one near middle, other at base, each about one foot thick (sample B62) 10

Sandstone, as above, contains abundant, thin, discontinuous seams of coal 1

Shale, black, fissile; at water level

CUMBERLAND COUNTY

Sample B10 - SW corner, sec. 27, T. 9 N., R. 8 E., 3 miles southwest of Jewett. Bluff on south side of Webster Branch, nearly on section line between secs. 27 and 28.

Covered; hill rises steeply from top of bluff to generally flat upland; bedrock, probably sandstone as below overlain by shale with chance of limestone and sandstone beds; probably considerable glacial drift 40

Mattoon Formation

Sandstone, massive, yellowish buff, medium grained; calcareous in places; few thin bedded, carbonaceous zones; base covered; calcareous portions not included in sample (sample B10) 15

EDGAR COUNTY

Sample B66 - NE 1/4 SW 1/4 SW 1/4 sec. 12, T. 12 N., R. 13 W., 3 1/2 miles southeast of Grand View. Bluff at bend in east-flowing tributary to West Big Creek, 1/2 mile east of road corner.

Glacial drift 5+

Mattoon Formation

Sandstone, massive, light brown, generally medium grained, coarser at bottom; lens of conglomerate 2 to 3 feet above base included in sample; ironstone nodules typically 1/2 inch in diameter scattered throughout but more abundant in basal 2 feet (sample B66) 20

Conglomerate 1

Sandstone, very calcareous; at water level

EDWARDS COUNTY

Ft. In.

Sample B58 - NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 18, T. 1 N., R. 10 E., at Blood Bluff east side of Little Wabash River at west edge of Blood at bridge.

rock probably sandstone overlain by shale; glacial drift of unknown thickness 30

Ft. In.

Covered; hill rises steeply from top of bluff; bedrock probably sandstone as below overlain by predominantly shale beds; thin glacial drift 20

Mattoon Formation

Mattoon Formation

Sandstone, massive, cross bedded, light brown, fine grained, soft and friable, slightly calcareous; contains lenses of harder, calcareous sandstone as much as 4 feet thick and 15 feet long; base covered (sample B8) 18

Sandstone, massive and thin bedded, light brown changing to gray in lower 3 feet, medium to coarse grained, slightly calcareous in places; base covered; calcareous portions not included in sample (sample B58) 10

FRANKLIN COUNTY

EFFINGHAM COUNTY

Sample B9 - NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 30, T. 8 N., R. 4 E., $3\frac{1}{2}$ miles northwest of Altamont. Bluff in ridge between two tributaries to Cedar Creek from south.

Sample B31A - NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 20, T. 7 S., R. 2 E., at north edge of Plumfield. Bluffs along east side of Muddy River, $\frac{1}{2}$ mile north of Plumfield. Exposures of massive and thin bedded sandstones at same elevation indicate that the massive sandstone occurs as lenses in the thin bedded stone.

Covered; apparently sandstone, thin bedded, shaly 10 $\frac{1}{2}$

Covered; hill rises about 20 feet in 100 feet from top of bluff to generally flat terrain; bedrock probably sandstone as below overlain by shale with chance of some limestone; thin glacial drift 20

Modesto Formation

Sandstone, massive, light brown, fine grained (sample B31A) 8
Covered to water; probably shaly sandstone 5

Mattoon Formation

Sandstone, massive in 2 to 4 foot beds with interbedded thin bedded zones which have carbonaceous partings; lower 10 feet gray, upper 10 feet buff; base covered (sample B9) 25

Samples B32A, B32B - SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 7 S., R. 4 E., $\frac{1}{2}$ mile south of Thompsonville. Railroad cut east of Thompsonville. Massive sandstone lenses in thin bedded, shaly sandstone. Samples taken from two different lenses.

Soil 2 $\frac{1}{2}$

Sample B56 - SE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 27, T. 6 N., R. 6 E., 3 miles west of Eberle. Outcrop in south bank of Ramsey Creek at mouth of tributary from south; scattered outcrops of massive sandstone along tributary.

Bond Formation

Sandstone, massive, buff to brown, medium grained, slightly calcareous (sample B32A) 12

Glacial till 10

Soil 2 $\frac{1}{2}$

Mattoon Formation

Bond Formation

Sandstone, thin bedded, shaly 5
Sandstone, massive, buff to brown, medium grained; base covered (sample B32B) 7

Sandstone, massive, light brown, medium to coarse grained; base covered (sample B56) 7

FAYETTE COUNTY

Sample B8 - S $\frac{1}{2}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 11, T. 5 N., R. 4 E., 3 miles southwest of Edgewood. Outcrop in bluff on the south side of an east-west tributary to Dismal Creek.

Sample B33 - SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 2, T. 6 S., R. 2 E., 2 miles northwest of Benton. Bluff on east side of Big Muddy River just south of mouth of Sugar Creek.

Covered; hill rises steeply from top of bluff; probably mostly shale. 30

Covered; hill rises 30 feet in 300 feet from top of bluff; bed-

Bond Formation

Sandstone, massive, thinner bedded in top 3 feet, buff, medium to coarse grained; base covered (sample B33)

12

FULTON COUNTY

Sample M9A - SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 10, T. 6 N., R. 1 E., 1 mile northeast of Marietta. Stream cut.

Carbondale and Spoon Formations

Shale; sandstone; carbonaceous shale or coal and clay interbedded

30+

Spoon Formation

Shale and sandstone interbedded

12

Siltstone, very clayey, thin beds

1

Sandstone, light tan becoming gray toward base, fine grained, dense, massive (sample M9A)

12

Clay shale, coal and shale

2

Sandstone

4

Coal; base covered

6+

Sample M10 - Center sec. 23, T. 6 N., R. 1 E., 1 mile northwest of Seville.

Gravelly sand and loess

10

Abbott Formation

Bernadotte Sandstone Member

Sandstone, tan, 2 to 12-inch beds, friable; base covered (sample M10)

9

Sample M40 - Center sec. 24, T. 3 N., R. 2 E., 4 miles southeast of Summum. Along Kerton Creek.

Soil

2+

Spoon Formation

Isabel Sandstone Member

Sandstone, fine to medium grained, tan, friable, micaceous, with scattered carbonaceous streaks; massive in lower 8 feet, thin bedded above; base covered (sample M40)

14

GALLATIN COUNTY

Sample B39 - SW $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4, T. 10 S., R. 8 E., 4 miles south of Equality. Ledges in floor of gully on southeast slope of Poplar Hollow.

Soil

1

Carbondale or Modesto Formation

Anvil Rock (or higher) Sandstone Member

Sandstone, massive, light brown, medium grained; base covered (sample B39)

20+

Samples B40A, B40B - NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 31, T. 10 S., R. 9 E., 5 miles northeast of Karbers Ridge. Ledges in stream and along bank southwest of Blue Blaze Coal Mine.

Covered; overburden increases rapidly a short distance back from stream; mostly shale and sandstone

40

Abbott Formation

Finnie Sandstone Member

Sandstone, massive, light brown to brown, medium grained; occasional thin cross-bedded zones with carbonaceous partings (sample B40A)

20

Shale

10

Sandstone, massive, light brown, fine grained; 1 foot at top and bottom is thin-bedded with carbonaceous partings; base covered (sample B40B)

7

Samples B101A, B101B - SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 3, T. 10 S., R. 8 E., 5 miles southeast of Equality. Core from diamond drill hole Bransford Mining Company No. 142.

Modesto Formation

No core

30

Sandstone, light gray, fine grained, slightly calcareous; shaly and carbonaceous streaks and partings; occasional 1 to 2-foot intervals of shale or interbedded sandstone and shale

26

Sandstone, light gray, fine grained, slightly calcareous (7% soluble in acid); thin carbonaceous streaks and specks (sample B101A)

19

Sandstone, as above, with abundant carbonaceous partings

4

Sandstone, light gray, medium to coarse grained, friable, slightly calcareous (10% soluble in acid); contains scattered sand-size fragments and occasional thin (1/8 inch) seams of coal (sample B101B)

46

Sandstone, as above, with abundant thin coal seams; shale pebbles in 1-inch thick layer at middle

3

Carbondale Formation

Bankston Fork Limestone Member
Limestone, gray

 $\frac{1}{2}$

GREENE COUNTY

Ft. In.

Sample B51 - SE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 24, T. 12 N., R. 11 W., 4 miles east of Roodhouse. High wall of coal strip mine.

Ft. In.

Carbondale Formation

Pleasantview Sandstone Member
Sandstone, thin bedded, gray, fine grained; carbonaceous partings; some interbedded shale 8
Sandstone, massive, light gray, fine grained 3
Sandstone, thin bedded, gray, fine grained; shale and carbonaceous partings 2
Sandstone, massive, light gray, fine grained; base covered 2
(Sample B51 includes all 4 sandstone units.)

south gully crossing abandoned road along south line of section.

Covered; slopes on either side of gully apparently underlain by sandstone as below 15±

Mattoon Formation

Sandstone, massive, cross bedded, brown, fine grained 10
Conglomerate lens; shale and sandstone pebbles; calcareous (51% soluble in acid) 0-4
Sandstone, as above 1
Sandstone, thin bedded, gray shale partings 1
Sandstone, in floor of gully; base covered
(Sample B43 from 3 uppermost sandstone units)

JACKSON COUNTY

GRUNDY COUNTY

Samples M32A, M32BC - NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 33 N., R. 7 E., 2 miles south-east of Morris. Bluff of Mazon Creek.

Clay and large boulders 2+

Carbondale Formation

Pleasantview Sandstone Member
Shale and calcareous sandstone 4
Sandstone, fine to medium grained, gray-brown, slightly friable; clayey zones in lower 9 feet; calcareous (sample M32A) 13
Sandstone, cross bedded, medium grained, slightly friable, micaceous 9
Sandstone, gray to brown, thin bedded, clayey, fine grained; lenses of medium grained sandstone; base covered 6
(Sample M32BC from lower 2 sandstone units)

Sample B26 - SW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 35, T. 7 S., R. 1 W., 3 miles northeast of Bush. Bluff in east bank Little Muddy River.

Soil 1-2

Modesto Formation

Sandstone, massive, buff, medium to coarse grained, micaceous; base covered (sample B26) 20

Sample B100 - SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 34, T. 7 S., R. 3 W., 2½ miles west of Oraville. Core from diamond drill hole no. 4 Albert White.

No core 21

Abbott Formation

Sandstone, white to light brown, fine grained, brown to dark brown limonite staining in places; few shale pebbles near base (sample B100) 24½
Shale, light gray 1
Sandstone, similar to above with zones of shale pebble conglomerate 9½
Sandstone, light brown, fine to coarse grained; brown to dark brown in places from limonite staining 4

HAMILTON COUNTY

Sample B41 - SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 24, T. 5 S., R. 5 E., 3 miles west of McLeansboro. Ledges along ditch and bank on east side of road across from Ten Mile Church.

Soil 1-2

Mattoon Formation

Sandstone, massive, buff, fine grained; interbedded with sandstone, thin bedded, buff, very fine grained; base covered (sample B41) 10

Sample B43 - SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 28, T. 4 S., R. 5 E., 7 miles northwest of McLeansboro. Ledges in north-

JASPER COUNTY

Sample B60 - SE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 8, T. 6 N., R. 10 E., 2 miles east of Newton. Cut north side of road.

Soil 1-2

Mattoon Formation

Sandstone, massive, light brown, medium grained (sample B60) 8
Shale, black, fissile; base covered

JEFFERSON COUNTY

Ft. In.

Sample B35 - SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 20, T. 2 S., R. 4 E., 1 $\frac{1}{2}$ miles north-east of Marlow. Roadcut on Route 15 exposes lenses of massive sandstone in shale. Sample from one of thicker lenses.

Soil	1
Mattoon Formation	
Shale	5
Sandstone, massive, buff to brown, medium grained (sample B35)	8
Shale; base covered	2

Sample B54 - NW $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 31, T. 4 S., R. 1 E., 4 $\frac{1}{2}$ miles east of Tamaroa. Bluffs along south bank Little Muddy River for about 1/8 mile east from bend to east, $\frac{1}{2}$ mile west of Rock Bridge.

Glacial drift	5
Bond Formation	
Sandstone, massive, occasional thin bedded zones, buff; few carbonaceous partings in lower 9 feet; base covered (sample B54)	15+

Sample B55 - SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 10, T. 1 S. R. 3 E., 2 miles east of Texico. Massive sandstone exposed in roadcut and in creek bank 200 to 300 feet north from bridge.

Glacial till	2-3
Mattoon Formation (?)	
Sandstone, massive, light brown, medium grained; weathered, soft and friable	8
Covered; probably sandstone as above	2
Sandstone, as above; base covered	9
(Sample B55 from the 2 sandstone units)	

LASALLE COUNTY

Samples M28A, M28B - N $\frac{1}{2}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 31, T. 33 N., R. 2 E. Roadcut in Matthiessen State Park.

Clay, stony	10+
Carbondale Formation	
Copperas Creek Sandstone Member	
Sandstone, as below but badly weathered	2
Sandstone, tan to brown, fine to medium grained; massive (sample M28A)	14
Sandstone, as above except thin bedded; base covered (sample M28B)	12

Sample M29 - NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 21, T. 33 N., R. 5 E., 1 mile southeast of Marseilles. Fresh cut along secondary road.

Clay, gravel, sand	20
Carbondale Formation	
Vermilionville Sandstone Member	
Sandstone, dark brown, fine to medium grained; in $\frac{1}{2}$ to 3-inch beds (sample M29)	12

Samples M30A, M30B, M30C - NE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 33 N., R. 4 E., at west edge of Marseilles. In east bank of Long Creek.

Covered; probably gravelly sand and sandy shale	10+
Carbondale Formation	
Vermilionville Sandstone Member	
Sandstone and shale interbedded, about 65 percent sandstone and 35 percent shale, thin bedded; shale is gray; sandstone light brown and friable, occurring in beds up to 1 $\frac{1}{2}$ inches thick (sample M30A)	14
Sandstone, light brown, massive; scattered, thin, shale partings (sample M30B)	12
Sandstone, light brown to gray, medium grained; a few shale zones up to 9 inches thick (sample M30C)	11
Shale, black, carbonaceous; base covered	3

Sample M31 - SE $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 26, T. 33 N., R. 3 E., 2 miles southeast of Ottawa. At east end of cutbank along Covell Creek.

Carbondale Formation	
Vermilionville Sandstone Member	
Sandstone, light gray and brownish gray, massive, friable (sample M31)	22
Undifferentiated	
Shale, sandstone, clay, and coal; base covered	80+

Sample M39 - NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 23, T. 31 N., R. 3 E. Bluffs of Vermilion River northwest of Streator.

Soil and sand	10
Carbondale Formation	
Vermilionville Sandstone Member	
Sandstone, massive, dense, tan; surface pitted by weathering	7
Sandstone, tan; beds $\frac{1}{2}$ inch to 6 inches thick separated by shaly sandstone up to 2 inches thick; thin	

ribbonlike masses of impure siderite between some beds 33

Canton Shale Member

Shale, sandy, laminated, gray; base covered 3
(Sample M39 from the 2 sandstone units)

LAWRENCE COUNTY

Samples B63A, B63C, B63AC - NW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 33, T. 5 N., R. 12 W., 1 mile north of Westport. 20-foot bluff east bank of Embarrass River, $\frac{1}{2}$ mile north of bridge at Westport.

Covered; hill rises 40 feet in 200 feet from top of bluff; probably sandstone as below overlain by predominantly shale beds 40

Mattoon Formation

Sandstone, massive, brown, coarse grained (sample B63C) 7
Sandstone, thin bedded, light brown, medium grained, calcareous (28% soluble in acid); occurs as lens 6 inches to 5 feet thick 3
Sandstone, massive, light brown, medium grained (sample B63A) 10
(Sample B63AC combines material from upper and lower units)

MARION COUNTY

Samples B52A, B52B, B52AB - SW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 32, T. 2 N., R. 2 E., 4 miles southwest of Salem. Outcrops along bluff south side Crooked Creek, east of bridge, 1 mile north of Lake Centralia. Upper 12' as ledges in steep gully 100' east of bridge; lower 13' in tributary valley from south, 400' east of bridge.

Covered; probably sandstone as below with more or less shale 10

Mattoon Formation

Sandstone, mostly thin bedded with an occasional bed 2 to 3 inches thick, light brown, very fine to fine grained; shale partings (sample B52B) 12
Covered; probably sandstone as above and below 6
Sandstone, as above, except light brown to gray near base of formation; base covered (sample B52A) 13
(Sample B52AB combines material from upper and lower sandstone units)

Sample B53 - NE $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 33, T. 2 N., R. 4 E., 3 miles southeast

of Iuka. Cutbank east side of Skillet Fork at sharp bend.

Covered; hill rises 50 feet in 200 feet from top of bluff; probably sandstone as below overlain by predominantly shale beds. 50

Mattoon Formation

Sandstone, massive with occasional thin bedded lenses, light brown, medium to coarse grained; zone 2 feet thick 7 feet from bottom contains cavities up to 1 inch diameter lined with limonite; base covered (sample B53) 12

MCDONOUGH COUNTY

Samples M8AF, M8C - NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 7, T. 5 N., R. 3 W., $\frac{1}{2}$ mile north of Colchester.

Loess 5+

Carbondale Formation

Pleasantview Sandstone Member
Sandstone, very badly weathered 3
Sandstone, fine grained, light brown, micaceous; lower foot calcareous 8
Shale, gray, sandy 8
Sandstone, fine grained, greenish gray, shaly, thin bedded, non calcareous; upper foot red-brown and massive 6 4
Sandstone, fine grained, clayey, very thin bedded, gray-greenish, micaceous; 2-inch gray shale parting at base 6
Sandstone, light tan, fine grained, massive 3
Sandstone, light gray, fine grained, thin bedded 5
(Sample M8AF from above 5 sandstone units)
Sandstone, dark reddish brown to light gray, fine to medium grained, thin bedded; base covered (sample M8C) 17

MERCER COUNTY

Sample M15 - NW cor. NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 2, T. 14 N., R. 3 W., 3 $\frac{1}{2}$ miles northeast of Aledo.

Loess 5

Abbott Formation (?)

Clay, sandy 6 6
Sandstone, light tan, dense 0-3
Limonite concretions, sandy 0-3
Sandstone, light gray to tan,

(MERCER COUNTY Cont.)		Ft.	In.		Ft.	In.
	dense, micaceous; in 1 to 4-inch beds (sample M15)	14		Sandstone, clayey, thin and irregularly bedded, fine grained, micaceous; contains a few sideritic bands	10	6
	Shale; base covered	10				
Sample M17 - SE $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 14 N., R. 1 W., 3 $\frac{1}{2}$ miles south of Hopewell.						
Sample M17 taken from 10 feet of sandstone, probably in the Isabel Sandstone Member of the Spoon Formation, exposed in an abandoned stream channel. The character of the material overlying the sandstone is obscure and the base of the sandstone is covered.						
MONTGOMERY COUNTY						
Sample B3 - SW $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 25, T. 9 N., R. 5 W., 2 miles northwest of Litchfield. Bluff on east side West Fork Shoal Creek, where stream makes sharp bend to south, about 1/8 mile south of road.						
Covered; probably sandstone as below in lower part overlain by predominantly shale beds						
Bond Formation						
McWain Sandstone Member						
Sandstone, massive, light brown, medium grained, micaceous, friable; lenses of sandstone, thin bedded with carbonaceous partings; 2-foot calcareous layer (28% soluble in acid) near top of exposure not included in sample (sample B3)						
Covered						
PEORIA COUNTY						
Sample M35 - NW $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 24, T. 8 N., R. 7 E., Bartonville. Road cut.						
Soil, very sandy						
Carbondale Formation						
Shale, gray						
Shale and coal interbedded						
Coal and clay interbedded						
Underclay						
Shale, gray						
Vermilionville Sandstone Member						
Sandstone, light gray, fine grained, micaceous, very clayey						
Sandstone, very hard, massive; makes lens commonly 6 inches to 2 feet thick, rarely absent						
Sandstone, like 7-foot bed above but gray						
Sandstone, like 1-foot bed above						
Sample M36 - SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 23, T. 8 N., R. 7 E., Bartonville. Road cut.						
Soil						
Carbondale Formation						
Shale						
Vermilionville Sandstone Member						
Sandstone and shale interbedded; sideritic concretions						
Sandstone, clayey and micaceous, mostly fine grained, carbonaceous (sample M36)						
Covered						
Shale; base covered						
Sample M37 - SW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 13, T. 8 N., R. 7 E., near Peoria. Along Kickapoo Creek.						
Soil and clay						
Carbondale Formation						
Vermilionville Sandstone Member						
Sandstone, argillaceous; poorly exposed						
Sandstone, massive, cross bedded, fine to medium grained, dense, calcareous, slightly argillaceous						
Covered						
Sandstone, like bed above; base covered						
(Sample M37 from the 2 lower sandstone units)						
PERRY COUNTY						
Sample B24 - SE $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 4, T. 3 S., R. 2 W., 9 miles northeast of Pinckneyville. Bluff along tributary to Beaucoup Creek.						
Soil						
Bond Formation						
Sandstone, massive, cross bedded, light brown, medium grained; base covered (sample B24)						

(PERRY COUNTY Cont.)		Ft. In.	RICHLAND COUNTY		Ft. In.
Sample B25 - S $\frac{1}{2}$ N $\frac{1}{2}$ W $\frac{1}{4}$ sec. 21, T. 5 S., R. 4 W., 3 miles north of Cutler. Bluff on east side Galum Creek at bend, 1/8 to $\frac{1}{4}$ mile south of Route 154.			Sample B59 - SW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 13, T. 3 N., R. 10 E., 3 miles southeast of Olney. Bluff east side of stream just north of bridge.		
Covered; sandstone as below; probably overlain by thin glacial drift		10	Soil		1-2
Modesto Formation			Mattoon Formation		
Sandstone, massive, few thin-bedded lenses, light gray to light brown, fine to medium grained, micaceous, friable except for one 6-inch lens 3 feet long; base covered (sample B25)		14	Sandstone, massive, cross bedded, light gray to light brown, fine grained; base covered (sample B59)		10
POPE COUNTY			ROCK ISLAND COUNTY		
Sample B36 - NW $\frac{1}{4}$ NW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 11 S., R. 5 E., $\frac{1}{4}$ mile south of Gldtown. Railroad cut.			Sample M12 - SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 6, T. 16 N., R. 5 W., 2 miles southeast of Muscatine, Iowa.		
Soil		1	Loess		5+
Abbott Formation			Spoon Formation		
Murray Bluff Sandstone Member			Isabel Sandstone Member		
Sandstone, massive, buff, gray in bottom 3 feet, coarse grained (sample B36)		20	Sandstone, yellow-brown, friable (sample M12)		30
RANDOLPH COUNTY			Undifferentiated		
Sample B18 - NW $\frac{1}{4}$ NE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 13, T. 5 S., R. 7 W., 3 miles west of Schuline. Bluff along east bank of Little Plum Creek, 150 feet north of bridge.			Clay shale, dark gray		18
Soil and silt		5+	Coal		2 $\frac{1}{2}$
Caseyville Formation			Sandstone		3
Sandstone, massive, cross bedded in part, buff to brown, medium grained, calcareous in places; ironstone nodules in two zones, each 1 to 2 feet thick; base covered; calcareous portions not included in sample (sample B18)		20	Clay		1
Sample B19 - SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 33, T. 6 S., R. 5 W., 4 miles west of Willisville. Bluff and stream-bed outcrops in continuous section downstream northeast from bridge for $\frac{1}{4}$ mile.			Shale, dark gray, base covered		21
Soil and silt		2-3	Sample M13 - NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 31, T. 17 N., R. 1 W., 2 miles southeast of Milan. Stream cut along Mill Creek.		
Abbott Formation			Covered		100
Babylon Sandstone Member			Abbott Formation		
Sandstone, massive, cross bedded in part, buff, medium grained; base covered (sample B19)		45	Shale, brownish gray		5+
ST. CLAIR COUNTY			Sandstone, brown, fine grained		1
Sample B14A - SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 6, T. 1 N., R. 8 W., 4 miles northwest of Belleville. 20-foot bluff west side of Shoenberger Creek, 1/8 mile downstream from Highway 161, 300 feet west of L. & N. Railroad.			Shale, dark gray		9
Covered; hill rises from top of bluff 30 feet in 100 feet, then another 40 feet in 500 feet to			Babylon Sandstone Member		

level of drainage divides; bedrock probably sandstone as below overlain by shale; probably considerable glacial drift chiefly as silt

70

Modesto Formation

Sandstone, massive, brown, medium grained, friable; ironstone nodules in band 3 feet from top (sample B14A)

15

Shale, gray, top 1 foot sandy

5

Covered to water; apparently shale as above

5

Sample B17 - SE $\frac{1}{4}$ SE $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 20, T. 1 S., R. 7 W., $\frac{1}{2}$ mile east of Freeburg. Massive sandstone in two adjacent exposures. Higher is 6-foot bluff on north side of road just west of bridge; lower is 12-foot bluff in west bank of Jacks Run, 200 feet north of bridge.

Covered; sandstone as below in lower part; probably mostly glacial drift above

20

Modesto Formation

Sandstone, massive, medium grained, light brown; some thin cross-bedded at top

6

Covered; probably sandstone as above

2

Sandstone, massive, medium grained, light brown; lower 5 feet is cross bedded with many carbonized plant remains; calcareous beds in basal 2 to 3 feet; base covered

12

(Sample B17 from the 2 sandstone units; calcareous layers in basal 2 or 3 feet not included in sample)

SALINE COUNTY

Sample B37 - NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 30, T. 10 S., R. 5 E. Railroad cut at Stonefort, along curving tracks from north-south C.C.C. and St. L. tracks to east-west I. C. tracks.

Soil

1

Spoon Formation

Sandstone, massive, cross bedded, light gray, fine grained, few thin-bedded zones with carbonaceous partings; base covered (sample B37)

15

Sample B38 - Near center NW $\frac{1}{4}$ sec. 16, T. 10 S., R. 6 E., 4 miles south of Harrisburg. Highwall of coal mine.

Spoon Formation

Palzo Sandstone Member

Sandstone, massive, light gray

to light brown, fine to medium grained, calcareous in places; occasional minor thin bedded zones with carbonaceous partings; bottom 3 feet thin bedded with carbonaceous partings; base covered; calcareous portions not included in sample (sample B38)

30

SANGAMON COUNTY

Sample M38 - NE $\frac{1}{4}$ SE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 2, T. 16 N., R. 5 W., near Springfield. In bank of Sangamon River.

Soil, sandy

3

Modesto Formation

Trivoli Sandstone Member

Sandstone, moderately friable, calcareous, in beds from 1 inch to 8 inches thick; contains scattered, thin, shaly layers; a few small clay nodules and limonite nodules present; base covered (sample M38)

40

SCOTT COUNTY

Sample B50 - NE $\frac{1}{4}$ SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 4, T. 13 N., R. 12 W., 1 mile east of Alsey. Bluff on south-flowing tributary to Little Sandy Creek.

Covered; hill rises 40 feet in 200 feet from top of bluff; bedrock probably sandstone as below overlain by predominantly shale beds; moderate thickness of glacial drift

40

Carbondale Formation

Pleasantview Sandstone Member

Sandstone, massive, light brown to brown, fine grained; two thin bedded lenses, one at middle, other near base, each average 1 foot thick (sample B50)

15

Covered to water; appears to be mostly black shale and coal

10

SHELBY COUNTY

Sample B5 - NE $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 17, T. 11 N., R. 3 E., 4 miles west of Shelbyville. Bluff on east side Robinson Creek where stream cuts into bank from west.

Covered; apparently sandstone as below overlain by glacial drift

5

Bond Formation

McWain Sandstone Member

Sandstone, massive, medium

(SHELBY COUNTY Cont.)		Ft. In.		Ft. In.
grained, buff, friable; thinner bedded in top and bottom 5 feet; band of ironstone concretions at base of upper thin beds (sample B5)		20	Sandstone, massive, cross bedded, light to dark brown, fine to medium grained; base covered (sample B69)	
Covered to water; probably sandstone as above		20	WARREN COUNTY	
VERMILION COUNTY			Sample M41 - NW $\frac{1}{4}$ NW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 14, T. 9 N., R. 1 W., four miles southeast of Berwick. Outcrop in west bank of stream.	
Sample M33 - SE $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 5, T. 19 N., R. 12 W. 2 miles northeast of Oakwood. Bluff along road.			Covered	
Modesto Formation			Abbott Formation	
Trivoli Sandstone Member			Sandstone, thin bedded, gray and white, with numerous carbonaceous streaks, shaly, micaceous	
Sandstone, fine to medium grained, thin bedded, micaceous; becomes clayey in upper 5 feet		10	Sandstone, gray and white, medium to fine grained, friable, abundant carbonaceous streaks; beds average about 1 foot thick; base covered (Sample M41 from the 2 sandstone units)	
Sandstone, medium grained, massive, micaceous		14	WASHINGTON COUNTY	
Sandstone, medium to coarse grained, cross bedded, micaceous; scattered lenses of tightly cemented sandstone; base covered (Sample M33 from the 3 sandstone units)		6	Sample B21 - NW $\frac{1}{4}$ NE $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 24, T. 2 S., R. 3 W., at east edge of Nashville. Bluff on west side of stream at bend to north, south edge Memorial Park.	
Sample M34 - SW $\frac{1}{4}$ SW $\frac{1}{4}$ NW $\frac{1}{4}$ sec. 32, T. 19 N., R. 13 W., $\frac{1}{2}$ miles northwest of Fairmount. Roadcut.			Covered; probably sandstone as below overlain by glacial drift	
Clay, sand, and gravel		15	Bond Formation	
Bond Formation			Sandstone, massive, buff, fine to medium grained; 1-inch shale seam about 3 feet above water; occasional carbonaceous partings and limonite-stained layers; base covered (sample B21)	
Sandstone, mostly fine grained, slightly friable, massive with irregular bedding, slightly clayey (sample M34)		13	Sample B22 - SE $\frac{1}{4}$ NE $\frac{1}{4}$ and SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 22, T. 2 S., R. 2 W., about 1 mile south of Beaucoup. Sandstone exposed as ledges along stream crossing road. Main outcrop is 5 feet high in east bank, 50 feet east of bridge; bottom 2 feet exposed in stream and bank downstream around bend; top 2 feet in bank 500 feet west of bridge.	
Shale; base covered		2	Glacial drift	
WABASH COUNTY			Bond Formation	
Sample B67 - NE $\frac{1}{4}$ NW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 19, T. 1 N., R. 11 W., 2 miles southeast of Allendale. Bluff along Wabash River.			Sandstone, massive and cross bedded, light brown to brown, fine grained, micaceous	
Covered; probably mostly glacial till and silt		20	Sandstone, thin bedded, fine to very fine, micaceous; carbonaceous partings in lower	
Mattoon Formation				
Sandstone, massive with thin cross-bedded zones, buff, medium to coarse grained; base covered (sample B67)		15		
Sample B69 - SW $\frac{1}{4}$ SW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 4, T. 1 S., R. 12 W., 2 miles north of Mt. Carmel. Bluff along Wabash River.				
Covered; probably sandstone as below overlain by glacial till and silt		10-15		
Bond Formation				
Mt. Carmel Sandstone Member				

few inches; base covered 2
 (Sample B22 from the 2 sandstone units)
 Sample B23C - SW $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 27, T. 3 S., R. 1 W., 1 mile northeast of Dubois. Roadcut on northwest side of road down hill (northeast) to creek.
 Covered, probably sandstone as below overlain by glacial drift 10

Modesto Formation

Sandstone, thin bedded, fine to very fine grained, argillaceous, becoming shaly in lower 5 feet; grades to black silty shale with streaks of sand at base; base covered (sample B23C) 15

WAYNE COUNTY

Sample B48 - NW $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 21, T. 2 S., R. 9 E., 2 miles south of Golden Gate. Bluff east side Little Wabash at Old Iron Bridge.

Soil 1

Mattoon Formation

Sandstone, massive, gray to light brown, medium to coarse grained; basal 3 feet calcareous in part; base covered; calcareous portions are 30% soluble; not included in sample (sample B48) 30

Sample B49 - SE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 32, T. 2 S., R. 8 E., 2 miles northeast of Barnhill. Sandstone exposed in small abandoned quarry, roadcut 75 feet east, and stream bed 50 feet south of quarry.

Soil 1

Mattoon Formation

Sandstone, massive, occasional thin bedded zones, light brown, fine to medium grained; exposed in quarry 5

Covered; probably sandstone as above 2

Sandstone, as above; exposed in roadcut 2

Sandstone, as above; exposed in stream bed; base covered 3

(Sample B49 from the 3 sandstone units)

WHITE COUNTY

Sample B44 - NW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 19, T. 5 S., R. 8 E., 2 miles southwest of Enfield. Ledges in ditch in abandoned north-south road about

$\frac{1}{4}$ mile south of St. Patrick's Church.

Soil 1

Mattoon Formation

Sandstone, thin bedded, light brown, fine to medium grained; little shale in basal 2 to 3 feet; base covered (sample B44) 10

Sample B45 - SW $\frac{1}{4}$ NE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 29, T. 4 S., R. 9 E., 5 miles northwest of Carmi. Bluff in northwest bank of Seven Mile Creek 50 feet north of bridge.

Soil 1

Mattoon Formation

Sandstone, massive to thin bedded, buff, fine grained; thin bedded layers somewhat shaly; one 3-foot bed 2 to 3 feet above base of outcrop is calcareous in part; upper 6 feet mostly massive, lower 4 feet mostly thin bedded; base covered (sample B45) 10

Sample B46 - SE $\frac{1}{4}$ NW $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 1, T. 7 S., R. 9 W., 3 miles northwest of New Haven. Bluff at fork in east-flowing tributary to Little Wabash River.

Covered; probably mostly shale and shaly sandstone 5±

Mattoon Formation (?)

Sandstone, massive, light gray to light brown, medium grained; base covered (sample B46) 10

Sample B47 - NW $\frac{1}{4}$ NE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 21, T. 3 S., R. 10 E., 6 miles north of Crossville. Bluff along east bank Little Wabash River.

Soil 1

Mattoon Formation

Shale 20

Sandstone, massive, light brown, medium grained (sample B47) 20

Covered to water; probably sandstone as above 3

WILLIAMSON COUNTY

Sample B27 - S $\frac{1}{2}$ N $\frac{1}{2}$ NW $\frac{1}{4}$ sec. 30, T. 9 S., R. 1 E., 3 miles east of Carbondale. Ledges exposed in spillway at southeast end of Crab Orchard Lake Dam; exposure about 100 feet wide and several hundred feet long.

(WILLIAMSON COUNTY Cont.) Ft. In.

Spoon Formation

Palzo Sandstone Member

Sandstone, massive, cross bedded, medium to coarse grained, apparently mostly white where fresh but mostly stained brown by iron oxide; base covered (sample B27) 40

Sample B28 - SE $\frac{1}{4}$ SW $\frac{1}{4}$ NE $\frac{1}{4}$ sec. 17, T. 10 S., R. 2 E., 3 miles northwest of Wolf Creek. Bluff in south side of ridge at intersection of tributary from east with flood plain of Wolf Creek.

Soil 1-2

Abbott Formation

Sandstone, massive, cross bedded, white to light brown, fine to medium grained; fairly well cemented; base covered (sample B28) 25

Sample B29 - NE $\frac{1}{4}$ SE $\frac{1}{4}$ SE $\frac{1}{4}$ sec. 25, T. 10 S., R. 3 E., 1 mile east of Creal Springs. Lower part of quarry and bluff along creek below quarry.

Covered; overburden varies from none at bluff below quarry to 70 feet at quarry face; mostly shale 0-70

Spoon Formation

Granger Sandstone Member

Sandstone, massive, cross bedded, light gray to buff, fine grained becoming coarser towards base; base covered (sample B29) 40

Sample B30 - NE $\frac{1}{4}$ SE $\frac{1}{4}$ SW $\frac{1}{4}$ sec. 36, T. 8 S., R. 4 E., 6 $\frac{1}{2}$ miles east of Pittsburg. Exposure in north part of railroad cut.

Soil 1

Modesto Formation

Trivoli Sandstone Member

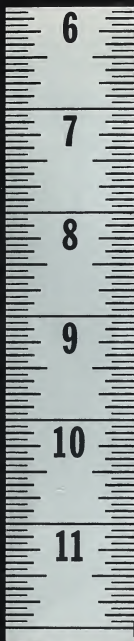
Sandstone, massive, cross bedded, buff, fine to medium grained; base covered (sample B30) 20

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